INTRODUCTION

The Flight Surgeon's Reference File contains material relating to professional and administrative procedures and policies of the AAF medical services. It represents a revision and consolidation of information previously available in the Flight Surgeon's Handbook, the Medical Officer's Guide, and other AAF aviation medicine publications. Editing, illustrating and printing of the Flight Surgeon's Reference File were supervised by the Office of Flying Safety.

Revision pages incorporating changes resulting from amendment of official policy and procedure will be issued periodically. It is the responsibility of each officer to whom a Flight Surgeon's Reference File is issued to note and insert revisions as they are released.

It is recognized that the time required for the preparation for initial presentation of a publication of this type will result in the inclusion of material which will not be applicable at the date of publication. Therefore, it is anticipated that the first revision pages will be issued shortly after the distribution of this edition.

The loose-leaf arrangement of the File is designed to facilitate the insertion of these revision pages as well as to permit the inclusion of supplementary material from other sources in accordance with the specialized needs of the individual officer.

Recommendations for inclusion of items in the Flight Surgeon's Reference File, criticism of materials or method of presentation of materials already included are invited and should be directed to:

Commandant
AAF School of Aviation Medicine
Randolph Field, Texas

It is the desire of the Air Surgeon that AAF medical officers become familiar with the contents of the Flight Surgeon's Reference File and use it as a ready reference for questions relating to professional and administrative problems.

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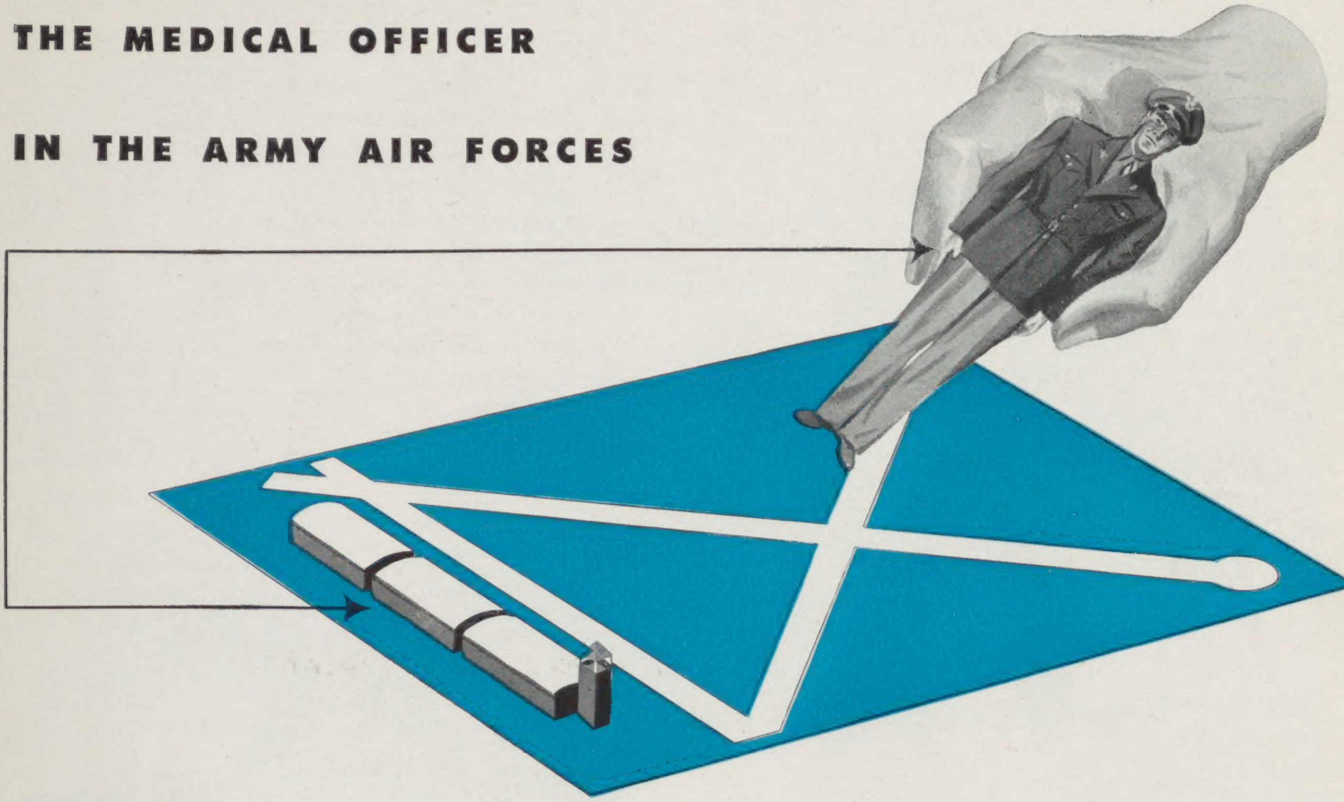
THE MEDICAL OFFICER

IN THE ARMY AIR FORCES



DUTIES

The duties of a Medical Corps officer in the AAF as in the Army itself, may be listed as:

1. *Professional:* Those duties incident to the practice of medicine, including physical examinations for the preservation and promotion of health.

2. *Advisory:* Those duties pertaining to a medical officer as a staff officer and medical technological advisor.

3. *Administrative:* Those duties pertaining to the command of Medical Department personnel and establishments and the patients therein. Only officers of the Medical Corps will command Medical Department organizations dealing with the diagnosis, treatment, hospitalization and transportation of sick and wounded personnel, except temporarily in an emergency when no Medical Corps officer is available.

ASSIGNMENT

As far as the military situation will permit, the following criteria will be utilized in determining the type of assignment an officer in the Medical Department of the AAF may expect:

1. *Desired Assignment:* It will be the policy of the Medical Department of the AAF to assign an officer those duties which lie within his primary interest. The fact cannot be refuted that interest in a particular assignment will result in better effort and better achievement.

2. *Physical Status and Age:* The necessity of physical well-being for successful accomplishment of many duties makes careful examinations and the use of exacting physical standards essential in deciding assignments. An officer assigned to an overeas tactical air force will endure physical hardships and will require physical stamina in excess of that needed by an officer for duty in a station hospital.

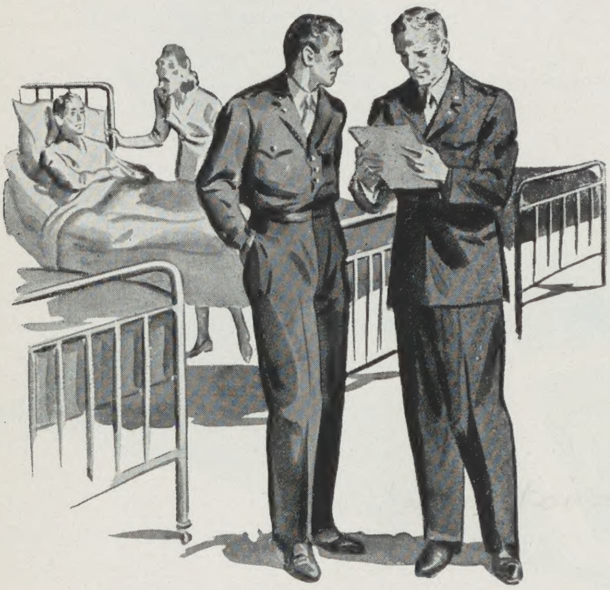
3. *Professional Qualifications:* AAF Regulation 35-51, which provided for AAF Manual 35-1 and WD AGO Form No. 66-3, greatly augmented the proper assignment of Medical Department officers. A professional assignment within the AAF will be based primarily upon the professional qualifications already demonstrated by the medical officer.

4. *Military Situation:* In all instances the military situation and any emergencies arising from it will be the final criteria for assignment. Apparent malassignments will necessarily result during an emergency.

CLASSIFICATION OF ASSIGNMENTS

Three main types of assignment exist within the Medical Department of the AAF:

1. Professional.



The actual care and treatment of the sick as well as the physical examination of the healthy for the safeguarding of health. Such an assignment is almost always in a hospital. An officer's suitability for such an assignment is based, for the most part, on his qualifications as described in AAF Manual 35-1 and as shown on WD AGO Form 66-3. The 25 military occupational specialties with the appropriate specifications serial numbers which may be given to Medical Officers are:

S.S.N.	M.O.S.
3001	Post surgeon
3100	Medical officer, general duty
3105	Gastro-enterologist
3106	Ophthalmologist and otorhinolaryngologist
3107	Cardiologist
3108	Obstetrician and gynecologist
3111	Urologist
3112	Dermatologist
3113	Allergist
3115	Anesthetist
3116	Medical officer, communicable disease
3125	Ophthalmologist
3126	Otorhinolaryngologist
3130	Neuropsychiatrist
3131	Neurosurgeon
3139	Medical officer, internist
3150	Medical officer, general surgery
3151	Thoracic surgeon
3152	Plastic surgeon
3153	Orthopedic surgeon
3155	Venereal disease control officer
3161	Air force staff surgeon
3303	Medical laboratory officer
3306	Radiologist
3325	Pathologist

2. Administrative.

The AAF base surgeon is the senior medical officer at a base. He is the commanding officer of the Medical Department of that base and as such is directly responsible to the commanding officer of the base for the discharge of the following duties:

Planning and supervising the operation of all base medical services, including dental, sanitary and veterinary activities.

Commanding all Medical Department personnel assigned to Medical Department facilities for the care and treatment of sick and wounded personnel.

Directing the professional medical training program for personnel assigned to duty with base medical organizations and installations. Giving technical supervision to other training programs which pertain to health, hygiene, sanitation, aviation medicine, and altitude training.

Supervising procurement, storage, issue and usage of medical supplies such as medical instruments, pharmaceuticals, drugs, and narcotics.

3. Tactical.

The staff medical officer and the flight surgeon in the tactical unit have tactical assignments. Normally there will be a staff medical officer for each unit in each echelon of command. The title of the staff medical officer on the staff of the Commanding General, AAF, will be "The Air Surgeon;" at all other levels the staff medical officer will be known as the "surgeon." The staff medical officer is directly responsible to the commanding officer for the performance of the following duties for the command:

Recommending measures for the prevention and control of injuries and diseases, both physical and mental.

Initiating and supervising measures for the care and treatment of the sick and wounded.

Under the direction of the commanding officer, commanding such Medical Department personnel of the unit or station as are not placed by competent authority under some other command or assigned to some subordinate tactical unit containing other Medical Department personnel.

Submitting such recommendations as to the training, instruction, and utilization of Medical Department personnel belonging to the command, including those not under his personal orders, as he may deem advisable.

Furnishing the commanding officer with information and advice on all questions affecting the Medical Department.

Taking necessary measures to insure that the required records are kept and the required reports are made by the Medical Department personnel of the command.

Exercising supervision over all Medical Department activities of the command.

In territorial commands, recommending to the commanding officer visits of inspection by himself or his assistants to such places within the territorial limits of the command as may be necessary for the purpose of inspecting Medical Department personnel, equipment, and administration and of investigating conditions affecting the health of military personnel.

Applying his knowledge of the human organism to the limitations placed on operations, tactics, and equipment by this organism, and making appropriate recommendations on this basis.

Developing and maintaining the highest possible efficiency of all AAF personnel, not only through maintenance of health, but also through the development and application of such protective devices as are necessary to attain this end. In addition, advising on the development, procurement, storage, issue, and usage of these devices.

Performing such other duties as may properly be prescribed by superior authority.

THE AVIATION MEDICAL EXAMINER

Any Medical Corps officer on duty with the AAF is eligible to apply for training at the AAF School of Aviation Medicine. He must, however, be physically capable of assuming a tactical position. A Medical Corps officer desiring such an assignment should make formal application for such, through channels, addressed to the commanding general of his own command. Accompanying such request will be a completed "64" physical examination made within 3 months of application. When the request is granted the medical officer is ordered to the AAF School of Aviation Medicine (see Section 2-6) for training in aviation medicine. After successfully completing this training, he returns to his proper station. He then becomes eligible for designation as an aviation medical examiner, for which he applies to the Commanding General, AAF. When this request is reviewed by Headquarters, AAF, the faculty proceedings from the AAF School of Aviation Medicine concerning the officer are noted, and if his request has been favorably approved by the commanding general of his command he is awarded such designation.

THE FLIGHT SURGEON

An aviation medical examiner may apply for designation as a flight surgeon whenever he has been:

1. An A.M.E. for a period of one year and has flown 50 hours in a military aircraft.

2. Actually been assigned and has arrived at an AAF unit in a theater outside the continental limits of the U. S.

3. Has had previous overseas experience with the AAF, which he may count month for month up to 9 months as credit toward the designation as flight surgeon, irrespective of the number of hours flown. Those officers in theaters outside the continental limits of the U. S. make application for designation as flight surgeon to the commanding general of the theater air force.

The duties of the flight surgeon are professional, administrative, and investigative.

Professional duties may be divided into those concerned exclusively with flying personnel and those concerned with all personnel of the unit. These duties may be listed as:

Selection
Maintenance } **of flying personnel**

Medical and surgical care
Prevention of disease and injury
Medical training } **of all personnel**

Flying Personnel:

"Selection" of applicants for flying training is an important duty of the flight surgeon in the Training Center and in the domestic areas. It principally involves the meticulous performance of the "64" examination.

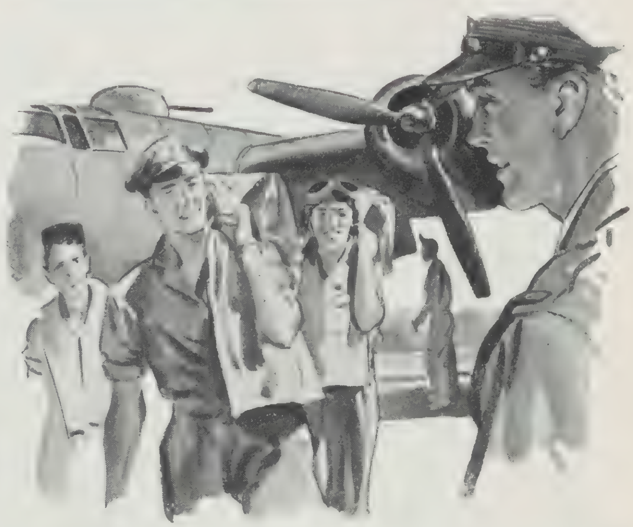
"Maintenance" of flying personnel is an all-inclusive expression used to indicate the flight surgeon's responsibility of keeping the flyer under his care in the best physical and mental condition at all times. It is the principal job of the squadron surgeon and of the flight surgeon on the large base.

Good maintenance of flyers presupposes certain things:

1. The flight surgeon must know the mental and physical condition of his flyers at all times. This may be learned in several ways. Conduction of *sick call* is an important one. In the continental United States this sick call is advantageously limited to flying personnel, unless the organization is functioning as an independent unit. *Physical examination* is another and may be made periodically by directive, after a significant illness or injury or for reasons indicating a change in flying status or a change in status from inactive to active duty. It includes the informal examination made when the flyer reports for flying duty at an AAF station. A study of previous *medical records* helps the flight surgeon to know the mental and physical background of individuals under his care. Successful maintenance will depend also on such *miscellaneous procedures* by the flight surgeon as visits to the flying line, presence on the line to observe all takeoffs and landings on tactical missions, discussions of personnel with squadron commanders, and active participation in the social, athletic and flying activities of the flyers.

2. The flight surgeon must be well versed in the physiology of flight and be able to pass this information on to his flyers with the help of the aviation physiologist and personal equipment officer. This duty is one of applying known physiological data, of practicing a type of preventive or industrial medicine. Its goal is to protect the flyer from the hazards of his environment and of the machine with which he works.

3. Morale of the flyer depends in many ways on the flight surgeon. Quality of the mess, health and sanitation of the command, recreational facilities, adequate sleep and sleeping conditions, and frequent leaves are morale factors over which the flight surgeon has considerable indirect control. A thorough knowledge of regulations concerning flying pay (see Section 5-2) permits the flight surgeon to expedite revocations or recissions of suspension to the financial advantage and good morale of the flyer.



4. The flight surgeon must be well versed in the psychology of flight and in recognition of psychological failures that occur particularly in the combat squadron. Such symptoms as anorexia, loss of weight, change in personality, change in drinking habits, tremor, irritability, or insomnia may be indications of an incipient neurosis.

All Personnel:

"Medical and surgical care" of all personnel in the small unit is the responsibility of the unit surgeon. It usually begins at sick call. Sick call is held at a time convenient for the unit and is best held separately for officers and enlisted personnel. Physical examinations for flying should not be made during sick call except in the case of minimal examinations concerned with grounding or revocation of grounding. On the large base the flight surgeon may make use of the professional personnel of the hospital for consultations. In the field such liaison is not usually possible although the squadron surgeons of a group, if operating in close proximity to each other, may make use of each other's special medical training in caring for the personnel of the group. The aviation dispensary, medical (see Section 2-4) may also prove useful in providing adequate medical care if the occasion should arise.

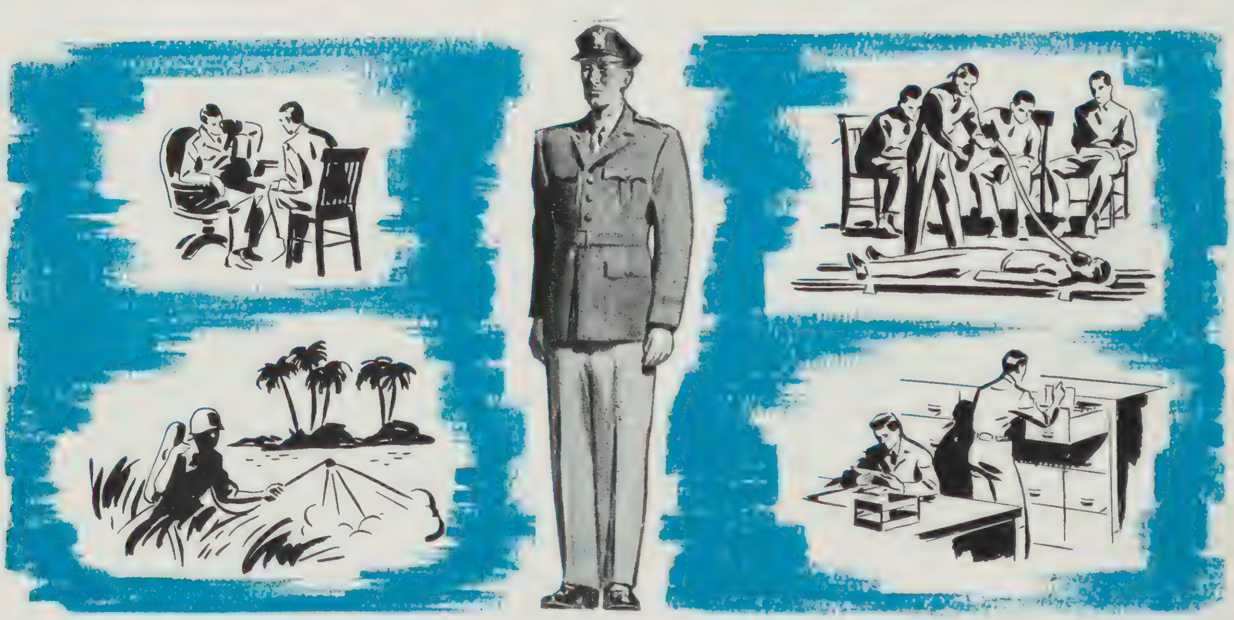
"Prevention of disease and injury" includes not only the measures to be used in protecting the flyer from his environment and from his machine, but also such general preventive medical procedures as immunization, sanitation afield and aloft, venereal disease control and the like (see Section 9).

"Medical training" must be carried on by the flight surgeon, particularly in the small unit, for all personnel. In medical training of flying personnel the aviation physiologist and the personal equipment officer, when available, help the flight surgeon in this function (see Section 10).

Administrative duties of the flight surgeon include the preparation and disposition of several medical records and reports pertaining to personnel of the organization. When the flight surgeon's office is an integral part of a fixed installation his responsibility is limited to the preparation of reports concerning flying personnel only (see Section 5-2). Changes in status of all flying personnel must be recorded progressively in order that up-to-date information concerning the flyer is available upon short notice. The Flight Surgeon's Records ("64 file" or "traveling file") must be forwarded promptly when flying personnel are transferred to a new station. The flight surgeon may be required to sit on various medical boards.

In small units his duties encompass all the duties of any medical officer.

Investigative duties include the responsibility of the flight surgeon to make continuous observations for improving the health of the command and for conducting experiments, if need be, to establish the worth of a medical procedure or piece of apparatus to accomplish this end. Reports of such studies are to be submitted to the Air Surgeon through channels.



FLYING STATUS FOR MEDICAL OFFICERS

It is the policy of the Commanding General, AAF, to award flying status only to those Medical Corps officers currently designated as aviation medical examiners or flight surgeons who are required by reason of their assignment to participate in regular and frequent aerial flights.

Medical Corps officers, designated as aviation medical examiners or flight surgeons, requesting flying status within the continental limits of the U. S. should submit their applications through command channels to the Commanding General, AAF. In theaters outside the continental limits of the U. S. officers make request for flying status through the air force commander within the theater. Aviation medical examiners or flight surgeons, under orders to depart the continental limits of the U. S., who are not on flying status, should submit their requests for flying status to the commanding general of the air force to which they are assigned only after arrival in the theater.

The rate of flying pay for aviation medical examiners is $60 per month; for flight surgeons it is one half the base pay per month.

REFERENCES

AAF Ltr. 25-12, Authorization of flying status for medical corps officers designated as aviation medical examiners and flight surgeons. 13 Jan 1945.

AR 35-1480, Aviation pay—officers, army nurses, warrant officers, and enlisted men, 10 Oct 1942.

AAF Manual 35-1, Military personnel classification and duty assignment, 3 Apr 1944.

AAF Reg 20-27, AAF school of aviation medicine, 13 Apr 1944.

AAF Reg 35-52, Designation of aviation medical examiner, flight surgeon, and flight nurse, 13 Apr 1944.

THE NURSING OFFICER IN THE AAF

General provisions regarding the Army Nurse Corps may be found in AR 40-20.

CLASSIFICATION

The Army Nurse in the AAF is classified in military occupational specialties as follows:

SSN	MOS
3430	Nurse, administrative
3430	Nurse, operating room
3445	Nurse, anesthetist
3449	Nurse, general duty

The requirements for each are listed in AAF Manual 35-1.

The Chief Nurse

The chief nurse is appointed by promotion from the grade of nurse. She is the administrative head of the nursing staff of a hospital, dispensary, or professional service within a hospital. The chief of the nursing staff of a hospital is known as the principal chief nurse. Chief nurses ordinarily perform both professional and administrative duties.

The Flight Nurse

Eligibility. The applicant for training as a flight nurse must have the following requirements.

1. Age: 21 to 36.
2. Physical: Ht.—62-72 inches.
   Wt.—105-170 lbs.
   Meet class 3 standards of AR 40-110.
3. Marital status: may be married.
4. Flying: must be willing to participate in regular and frequent aerial flights.
   Application is made by the nurse through channels to the command surgeon.

Training. When accepted for training the nurse is ordered to the AAF School of Aviation Medicine to take the 9-weeks course in air evacuation (see Section 2-5). After successful graduation the designation of flight nurse is not automatic, but must be requested through channels to the Commanding General, AAF.

Flying Status for Nurses

Flight nurses on flying status are regarded as non-flying officers (non-rated). Flying pay amounts to $60 per month.

REFERENCES

AAF Manual 35-1, Military personnel classification and duty assignment, 3 Apr 1944.
AR 40-20, Army Nurse Corps, 5 Apr 1943, C8 27 Nov 1944.
AAF Ltr. 50-23, Application for training as flight nurse, 11 May 1944.
WD Circ. 98, Qualification for flight nurse, 8 Mar 1944.
AR 35-1480, Aviation pay, 10 Oct 1942.

THE MEDICAL SOLDIER IN THE AAF

Classification

With the publication of AAF Manual 35-1, the total number of authorized military occupational specialties peculiar to the enlisted Medical Department of the AAF was reduced to 13. These include the new specialty, medical corpsman, SSN 657, together with 12 other specialties reserved for more highly qualified technicians.

Training

The unit surgeon is authorized and directed to accomplish the technical and tactical training of medical enlisted personnel, and to exercise general control and supervision of this training. Military training for all Medical Department personnel is the responsibility of the director of operations and training or similar staff officer, coordinating such training with the surgeon.

Eligibility

To be eligible for training as a medical corpsman it is desirable that enlisted personnel be selected who have an AGCT score of 90 or above, have completed high school, and are physically fit for overseas duty, unless it is contemplated assigning them to zone of interior installations. Men having an AGCT rating of 110 or above will probably qualify for training in the higher Medical Department specialties.

The Basic Medical Department Soldier

Medical corpsman, SSN 657, is the basic classification of each enlisted man of the Medical Department on duty with the AAF. AAF Training Standard 80-657 prescribes his training and sets the standard for his proficiency and qualifications. He is further classified on the basis of training into:
Semiskilled: Capable of acting under supervision as an assistant in the care of patients and able to administer first aid treatment to the seriously injured and wounded.
Skilled: Capable of assisting in the care and treatment of patients with a minimum of supervision; familiar with records and facilities of medical installations; proficient in the administration of plasma; able to supervise the operation and maintenance of a venereal prophylactic station.
The Medical Corpsman with specialized training. There are at present three categories of medical corpsmen that require additional specialized training, yet carry no distinctive specification serial number. These are: the flight surgeon's assistant, the dental chair assistant, and the ambulance driver. Tables of organization requiring one of these specially trained basic medical soldiers call for a medical corpsman (SSN 657), with a notation explaining that he is to be qualified in one of the above. These qualifications are as follows:

The flight surgeon's assistant: Should be proficient

as a semi-skilled medical corpsman (see below).

The dental chair assistant: Should be proficient as a semi-skilled medical corpsman; have a practical knowledge of Chest MD No. 60; be proficient in the mixing of dental filling materials; be able to render emergency dental treatment; know dental forms and records; be able to assist the dental officer in all chair duties; be able to clean teeth.

The ambulance driver: Should be proficient as a semi-skilled medical corpsman; be a competent driver with knowledge of map reading; be thoroughly familiar with proper methods of loading and unloading an ambulance; know how to transport various types of casualties; have knowledge of property exchange.

Medical Department Specialists

Proficiency as a medical corpsman, SSN 657, is a prerequisite for every Medical Department specialist. There are 12 such specialists, 6 requiring previous qualification as a medical corpsman, semi-skilled, and 6 requiring previous proficiency as a medical corpsman, skilled. Upon attaining the required standard of proficiency, the medical corpsman selected for specialized training receives the specification serial number of that specialty in either a semi-skilled or skilled status as follows:

Semi-skilled specialist: Capable of assisting in, or performing under supervision, the various operations and procedures peculiar to his specialty.

Skilled specialist: Capable of performing or supervising the various operations and procedures peculiar to his specialty.

Medical specialist with M.O.S. prerequisite of medical corpsman (semi-skilled).

S.S.N.	M.O.S.
067	Dental laboratory technician
120	Meat and dairy inspector
196	Sanitary technician
365	Optician
825	Medical supply technician
859	Pharmacy technician

Medical specialist with M.O.S. prerequisite of medical corpsman (skilled).

S.S.N.	M.O.S.
264	Radiology technician
366	Orthopedic mechanic
409	Medical technician
673	Medical administrative specialist
858	Medical laboratory technician
861	Surgical technician

Other Specialists in Medical Department Organizations

In tables of organization and equipment of medical department organizations, there are other specialists who have military occupational specialties common to other branches of the service. These usually consist of housekeeping personnel, such as cook (SSN 060), clerks (SSNs 502, 405, 055, 835), motor trans-

portation technician (SSN 014). Such specialists are classified with non-medical department specification serial numbers.

When these specialists are assigned to medical units, they are usually called upon to perform some medical duties with which they are not familiar. In many instances, this will mean that these specialists must be given considerable basic Medical Department training. This is particularly true in tactical medical sections and units where each man should possess a degree of proficiency equal to that of the medical corpsman, regardless of his primary military occupational specialty.

Hospital and Field Components of Medical Department Occupational Specialties

At the present time, there is no clear distinction between the military occupational specialty and specification serial number for a zone of interior hospital technician and a tactical or field technician. Although the duties of each are very similar, the manner in which these duties are accomplished and the equipment and facilities with which these specialists work may be so different that neither can efficiently carry out the assignment of the other without added training. AAF Regulation 50-28 directs technical, tactical and field (MOS) training for medical enlisted personnel. At present, AAF hospitals carry on the hospital aspects of Medical Department technical training in accordance with AAF Letter 50-66, and the tactical and field aspects are handled by the AAF Medical Service Training School and the AAF School of Aviation Medicine (Department of Air Evacuation).

The Flight Surgeon's Enlisted Assistant

The flight surgeon's enlisted assistant is a medical corpsman trained at the AAF School of Aviation Medicine for duty in the flight surgeon's office as a non-commissioned officer and as a technical assistant.

The course of instruction he receives consists of 242 hours over 6 weeks. Approximately 90 hours are devoted to anatomy, laboratory procedures, and practical performance of parts of the ophthalmological and general physical examinations. The remaining hours are divided between field work and administration of the Medical Department.

Certain requirements must be met by an enlisted man desiring to pursue this course of instruction. He must be in the regular army or be a selectee who has expressed a desire to remain in the service after the war; be currently engaged in Medical Department activities with the AAF; meet the special requirements listed below:

1. Age: 18 to 36, inclusive.
2. Must be physically qualified as prescribed in par. 10, AR 40-100.
3. Mental:

a. Must be a high-school graduate or have equivalent training.

b. Must have demonstrated special aptitude and desire for work in aviation medicine.

4. Military experience: Must have completed basic training and served at least 3 months under the officer or officers making selection.

The Air Evacuation Medical Technician

The prerequisites for air evacuation training given by the Department of Air Evacuation at the AAF School of Aviation Medicine are that the enlisted man have a rating of medical technician, semi-skilled (409) and be a graduate of the AAF Medical Service Training School (see Section 2-5). At the AAF School of Aviation Medicine he receives some additional technical training during an 8-weeks course, but the bulk of the time is devoted to familiarizing him with aircraft litter installations, aircraft loading of wounded, aviation physiology, and aerotherapeutics.

REFERENCES

AAF Reg 35-51, Classification and duty assignment, 3 Apr 1944.

AAF Manual 35-1, Military personnel classification and duty assignment, 3 Apr 1944.

AAF Letter 35-80, Classification of Medical Department personnel with the Army Air Forces, 19 Apr 1944.

AAF Reg 50-28, Medical training of AAF personnel and military training of medical personnel. 1 Aug 1944.

AAF Training standards of the 80-000 series, 11 May 1944.

AAF Reg 20-27, AAF school of aviation medicine, 13 Apr 1944.

AAF Reg 20-28, AAF medical service training school, 17 Oct 1944.

AAF Ltr. 50-66, Training of medical department soldier, 21 Nov 1944.

THE AVIATION PHYSIOLOGIST

The aviation physiologist is an officer who has been selected and trained for the purpose of conducting the AAF Altitude Training Program (see Section 10). Most of these officers possess a doctor of philosophy degree in one of the biological sciences and have been commissioned in the Air Corps specifically for this duty. Among the factors taken into consideration in the selection of these men are scientific training and accomplishments, teaching ability, personality, energy, initiative, and resourcefulness. These men are certified as aviation physiologists (SSN 3327) upon satisfactory completion of the course of instruction in aviation physiology at the AAF School of Aviation Medicine.

A considerable number of medical officers, in most cases with special training in physiology, have also been certified as aviation physiologists after completion of the required course of instruction and have been assigned to duty with the Altitude Training Program.

The aviation physiologist, in his efforts to familiarize aircrew trainees with the physical conditions and physiological stresses encountered in military aviation and with the methods of meeting those hazards, employs numerous teaching methods. Among these are lectures, quizzes, discussions, demonstrations, exhibits, training films and, most important of all, simulated flights in the altitude chamber.

Other specific duties of the aviation physiologist include the keeping of records, the collection of data and the conducting of pertinent research. These duties are common to all aviation physiologists in whatever branch they may be commissioned. The medical officer assigned to the Altitude Training Program as an aviation physiologist will, however, make the prevention, care and study of physical reactions to simulated high altitude matters of particular concern. Safeguarding the health of the personnel assigned to the Altitude Training Program, particularly the enlisted men whose duties involve repeated exposure to simulated high altitudes (altitude chamber technician, SSN 617), is another responsibility of the aviation physiologist, particularly the medical officer.

The routine altitude chamber flight is planned primarily as an indoctrination procedure, but the physical response of the individual to such a flight will be considered by the flight surgeon as pertinent evidence bearing upon the fitness of the individual to fly. In addition, special individual flights can be arranged for diagnostic purposes. The altitude chamber has proven an extremely valuable clinical tool. The wise flight surgeon will utilize fully the particular qualifications and skills of the aviation physiologist in the planning of such flights and in the interpretation of their results.

REFERENCES

AAF Reg 50-18, Altitude training program, 3 Oct 1944.

THE AVIATION PSYCHOLOGIST

The aviation psychologist (SSN 2251) is an Air Corps officer with a doctor of philosophy degree or its equivalent in the field of psychology who is assigned for duty with the Medical Department of the AAF. Many of these officers were employed in universities and in industry and were commissioned in the Air Corps specifically for duty in the Aviation Psychology Program. Others are reserve officers or selected graduates of officer candidate schools. The professional training and experience of the aviation psychologist has been in research concerned with such problems as test construction, selection of personnel for special jobs, and the objective measurement of individual aptitude, learning proficiency and adjustment. In addition to research he may have been engaged in the application of psychology to problems of clinical diagnosis, guidance, and education.

Aviation psychologists have been assigned to the development of procedures for selecting and classifying applicants for air crew training and to research work on other special problems. The following summary of the activities of the Aviation Psychology Program indicates the types of duty that these personnel are qualified to perform:

Development of tests for selection and classification of aircrews. Tests for the initial selection of applicants for aircrew training, and for the classification of individuals for fighter pilot, bomber pilot, navigator, bombardier, career gunner, mechanic-armorer gunner, and radio gunner training are developed for use in the AAF Training Command.

Development of tests and procedures for the better utilization of experienced personnel. Tests for the selection of rated flying officers for such special assignments as pathfinder and lead crew duties, the selection of returned combat personnel for assignment as instructors, the selection of personnel for radar operator training and the selection of gunnery officers are developed to meet changing operational requirements.

Development of proficiency tests. Aviation psychologists, in cooperation with rated flying personnel, have undertaken the development of proficiency tests for various of the specialized aircrew duties. Tests include phase checks for flexible gunners, navigator and bombardier proficiency tests, radar proficiency tests, a proficiency test in aircraft recognition, an objective scale of flying skill for pilots, and an objective scale of navigation ability. Research procedures used in developing such proficiency tests are similar to procedures employed in constructing and validating aptitude tests.

Psychological services in AAF Convalescent Hospitals. Aviation psychologists assigned to AAF Convalescent Hospitals assist in diagnosing the condition and basic aptitudes of incoming patients, and in measuring the progress made during convalescence. They assist in planning a convalescent program fitted to individual needs and conduct an orientation and counselling service.

Study of psychological problems in the design and use of equipment. Studies in this field are concerned with the problem of designing equipment so that it can be used most effectively by the average operator. Research studies are made of human factors related to the design of both instruments and control mechanisms.

Follow-up studies. Most of the activities listed above require careful experimentation, including follow-up studies designed to determine the relative value of alternative tests or procedures. Aviation psychologists have had wide experience in designing and conducting research studies of this sort.

The aviation psychologist working in coordination with the AAF medical program brings the techniques and procedures of experimental and applied psychology to bear upon problems of aviation. In addition to work concerned with selection and classification, the aviation psychologist conducts research on other problems which require the use of reliable objective tests of human behavior or experimental study of the human factor in training, redistribution and utilization of personnel.

REFERENCES

AAF Manual 35-1, Military personnel classification and duty assignment, 3 Apr 1944.

THE PERSONAL EQUIPMENT OFFICER

The personal equipment officer (SSN 1042) supervises maintenance and instructs in the use of emergency equipment, individual flying equipment, oxygen equipment, sea rescue equipment and related items.

Training for the PEO is at present given at the AAF School.

The personal equipment officer is primarily a coordinator. His duties in a combat unit cut across channels of supply, maintenance, inspection, and training. In this sense the personal equipment officer and the flight surgeon stand together. Their common interest is the welfare of the flyer, and both strive to maintain the greatest number of individuals on flying status. While the methods of the flight surgeon are both preventive and curative, the personal equipment officer approaches his job entirely from the preventive angle.

If the training program which personal equipment officers are required to carry out is to be of value to combat crews, he must give them guidance. The flight surgeon is in a particularly advantageous position to be of assistance to the PEO. He knows the men and operational conditions; he can speak convincingly to them of the value of the whole program which the personal equipment officer supports. The flight surgeon can best act, by virtue of long training and the discipline of study, as an aid in planning and carrying out the training program for aircrews. In addition to this indirect assistance, the flight surgeon can conduct those phases of instruction which pertain to the purely medical aspects of personal and protective equipment.

REFERENCES

AAF Reg 55-7, Personal equipment officer, 28 Oct 1944.
AAF Reg 55-7a, Personal equipment officer, 4 Mar 1944.
AAFSAT, Reference manual for personal equipment officer, 1 Sept 1944.

THE MEDICAL INSPECTOR

The medical inspector is a duty designation for the medical officer concerned with preventive medicine in a command.

Under the surgeon he is charged with the responsibility of recommending and supervising an adequate program of preventive medicine for the command or station to which assigned. This program will include supervision of personal hygiene and environmental sanitation, control of communicable disease, including venereal and insect borne disease, evaluation of all phases of sanitary engineering, and control of nutritional deficiencies.

The medical inspector has no MOS, but if specifically detailed to full time duties, he is to be qualified in preventive medicine as evidenced by civilian experience in public health or military experience in preventive medicine.

REFERENCES

AR 40-200, Medical inspector, 3 Nov 1944.

FOOD AND NUTRITION OFFICERS

Food and nutrition officers (SSN 3316) are professional specialists whose activities lie in the borderline region between the Medical Department and the Quartermaster Corps. They represent the medical point of view toward Quartermaster responsibilities in feeding troops adequately. They are assigned to such air forces, stations, or other units as the Commanding General, AAF, shall direct. They exercise no command functions.

Eligibility and Requirements

Nutrition officers must be graduates of a college or university and must have several years of experience in nutrition or in the nutritional aspects of physiology, biochemistry, or food chemistry. Their specialized training in both nutrition and experimental methods should equip them for the procurement of exact and reliable data on messing and actual food consumption and for active liaison with the Food Service Program of the Surgeon General.

For initial appointment to the grade of first lieutenant, 3 years of the experience requirements may be waived provided the applicant holds the degree of doctor of philosophy, doctor of science, or a certificate indicating completion of work for such degree from a recognized college or university.

Training

In addition to the professional training required for appointment, the food and nutrition officer spends 6 weeks in basic military training at Carlisle Barracks. This is followed by approximately 2 months of training in the nutrition course at the Army Medical School and 30 days of temporary duty in conducting nutritional surveys of troop messes.

Duties and Responsibilities

Food and nutrition officers are members of the surgeon's staff and will be utilized as food and mess inspectors. After studying rations and mess operations, including the selection, distribution, preparation, and serving of food, they advise the surgeon on matters pertaining to food and nutrition affecting the health of all personnel within the command.

Among their specific responsibilities are:

To make recommendations for the correction of defects or deficiencies and for the inclusion of vitamin concentrates as an article of ration.

To collect data on food preparation, nutritive value of foods, and adequacy of rations.

To study the adequacy of food consumed by the soldier through nutritional surveys of messes and individual mess analysis.

To cooperate with the Quartermaster Corps in an advisory capacity on nutritional matters.

To assist with the instruction of officers and enlisted men regarding nutrition and the attainment of adequate dietary standards.

Reports

The food and nutrition officer prepares for the surgeon a monthly Food and Nutritional Report which summarizes the observations made during the month and includes appropriate recommendations. Those parts will be included in the Monthly Sanitary Report as the surgeon deems advisable.

In addition, special reports go to the surgeon as he requires from time to time.

REFERENCES

SGO Circ. Ltr. No. 15, Functions of food and nutrition officers, 21 Feb 1942.

WD Circ. 45, Hq. ASF, Food service program, 3 Jul 1943.

TM 12-406, Officer classification, commissioned and warrant, 30 Oct 1943.

MISCELLANEOUS PERSONNEL

There are personnel in the AAF with whom the AAF medical officer will have more or less close professional contact. These include officers of the Medical Administrative Corps, Dental Corps, Sanitary Corps, Pharmacy Corps, and Veterinary Corps, and such specialists as the physical therapy aide (SSN 3418) and the hospital dietitian (SSN 3420). Because the functions of these officers in the AAF do not differ from their functions in the ASF and AGF, they are not detailed here.

REFERENCES

AR 40-15, Dental Corps, general provisions, 28 Dec 1942.

AR 40-2010, Duties and titles of veterinarians, 27 Nov 1942.

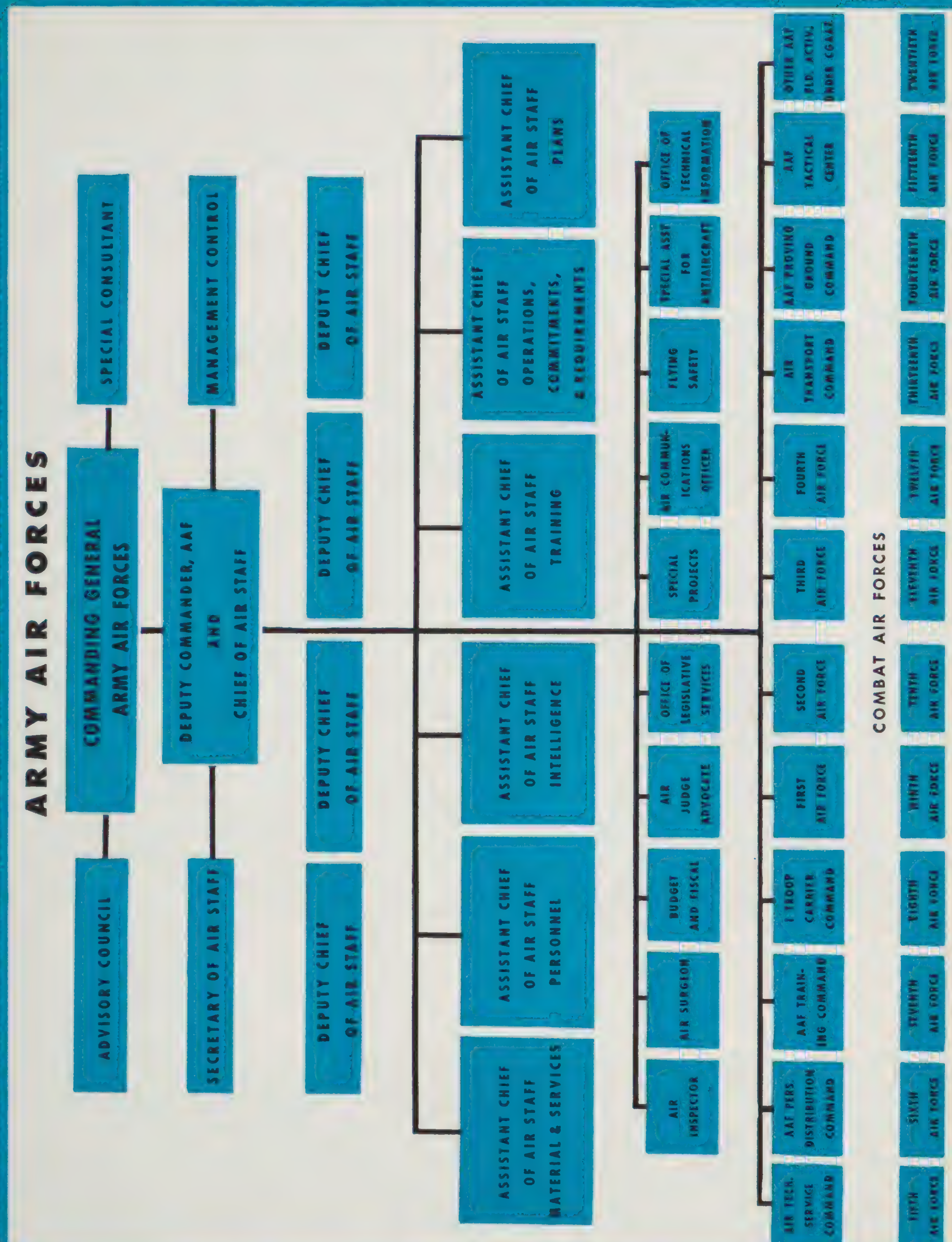
SECTION 2

ORGANIZATION

SECTION 2

ORGANIZATION

1. Army Air Forces.
2. Air Surgeon's Office.
3. Medical Service of AAF Commands.
4. Medical Service of an Air Force.
5. AAF Schools and Research Laboratories.
6. Miscellaneous Installations.
7. Dental Service in the AAF.
8. The Flight Surgeon's Office.


ARMY AIR FORCES
COMMANDING GENERAL ARMY AIR FORCES
SPECIAL CONSULTANT
ADVISORY COUNCIL
DEPUTY COMMANDER, AAF AND CHIEF OF AIR STAFF
MANAGEMENT CONTROL
SECRETARY OF AIR STAFF
DEPUTY CHIEF OF AIR STAFF
DEPUTY CHIEF OF AIR STAFF
DEPUTY CHIEF OF AIR STAFF
DEPUTY CHIEF OF AIR STAFF
ASSISTANT CHIEF OF AIR STAFF PLANS
ASSISTANT CHIEF OF AIR STAFF OPERATIONS, COMMITMENTS, & REQUIREMENTS
ASSISTANT CHIEF OF AIR STAFF TRAINING
ASSISTANT CHIEF OF AIR STAFF INTELLIGENCE
ASSISTANT CHIEF OF AIR STAFF PERSONNEL
ASSISTANT CHIEF OF AIR STAFF MATERIAL & SERVICES
OFFICE OF TECHNICAL INFORMATION
SPECIAL ASST FOR ANTIAIRCRAFT
FLYING SAFETY
AIR COMMUNICATIONS OFFICER
SPECIAL PROJECTS
OFFICE OF LEGISLATIVE SERVICES
AIR JUDGE ADVOCATE
BUDGET AND FISCAL
AIR SURGEON
AIR INSPECTOR
OTHER AAF FLD. ACTIV. UNDER CGAAF
AAF TACTICAL CENTER
AAF PROVING GROUND COMMAND
AIR TRANSPORT COMMAND
FOURTH AIR FORCE
THIRD AIR FORCE
SECOND AIR FORCE
FIRST AIR FORCE
I TROOP CARRIER COMMAND
AAF TRAINING COMMAND
AAF PERS. DISTRIBUTION COMMAND
AIR TECH. SERVICE COMMAND
COMBAT AIR FORCES
TWENTIETH AIR FORCE
FIFTEENTH AIR FORCE
FOURTEENTH AIR FORCE
THIRTEENTH AIR FORCE
TWELFTH AIR FORCE
ELEVENTH AIR FORCE
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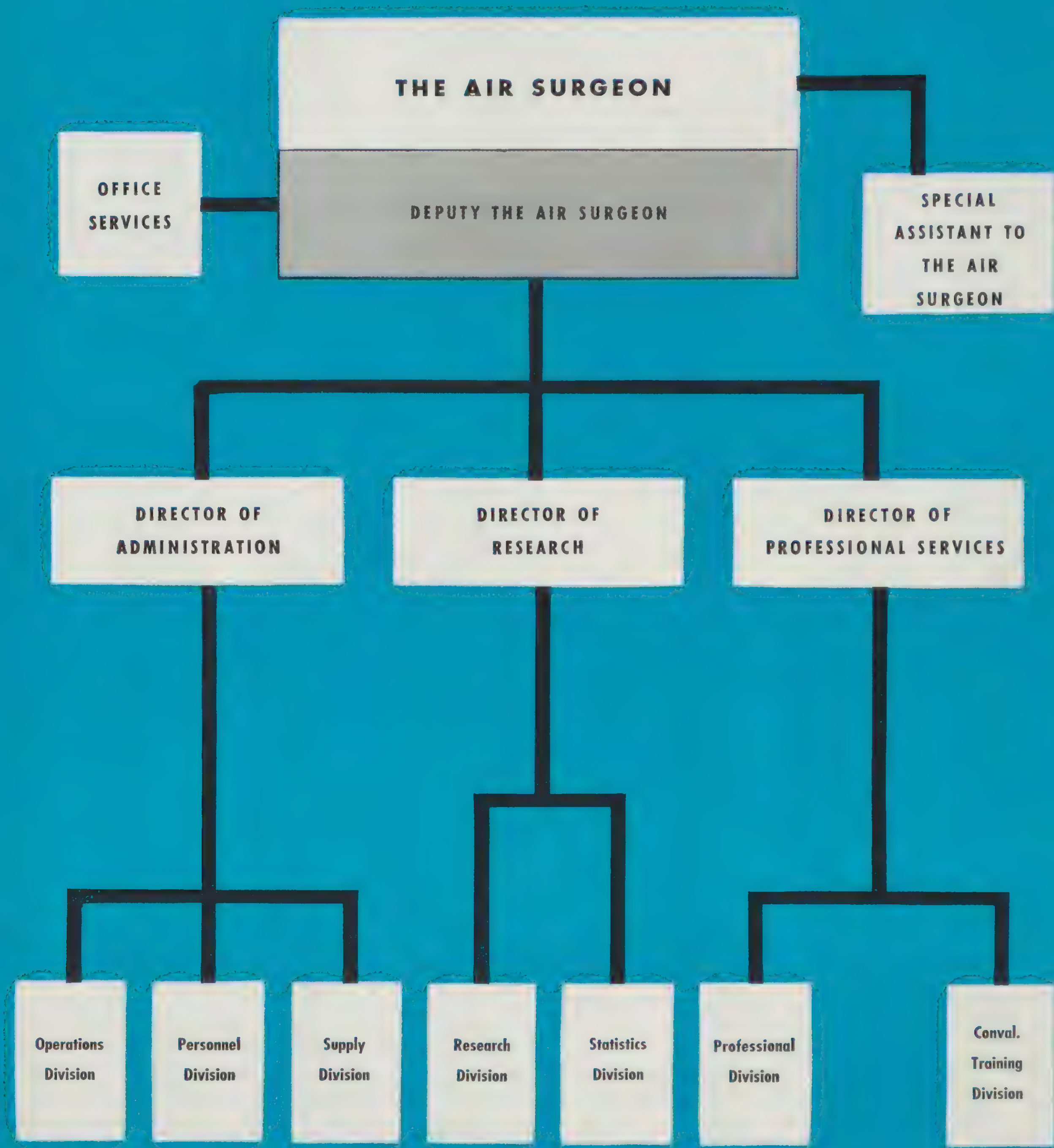
SEVENTH AIR FORCE
SIXTH AIR FORCE
FIFTH AIR FORCE



Approved by The Air Surgeon:

21 November 1944

MEDICAL SERVICE OF AAF COMMANDS

AIR TRANSPORT COMMAND MEDICAL ORGANIZATION

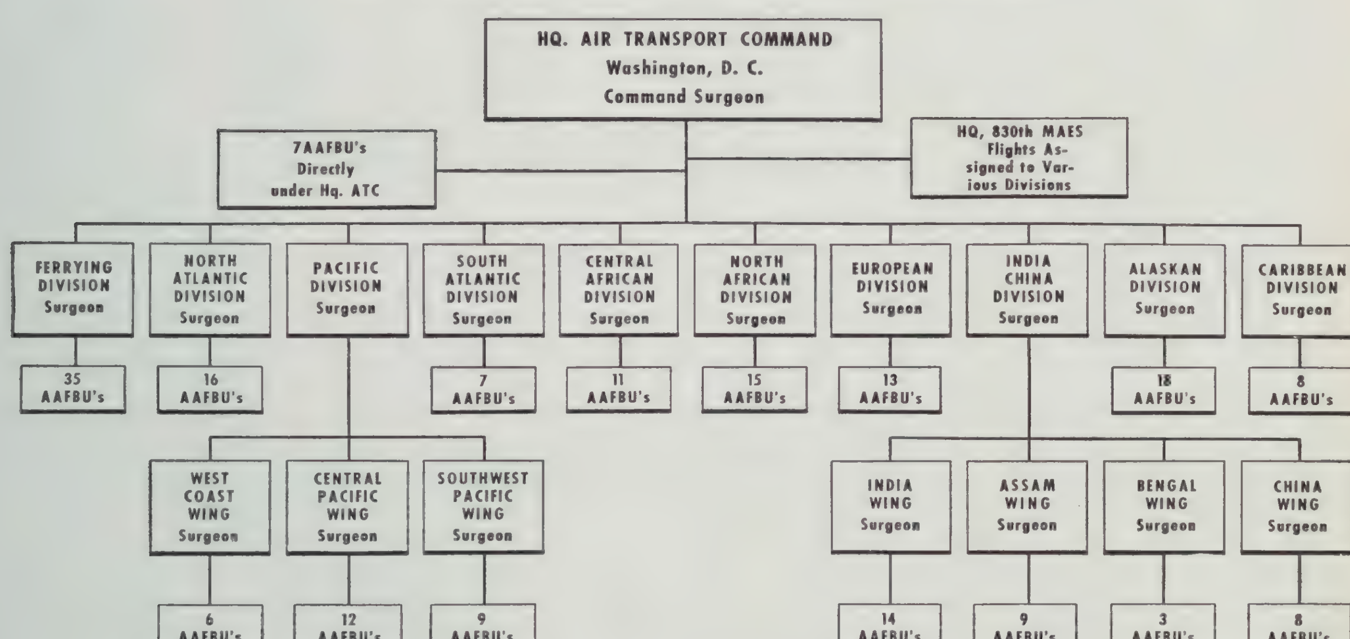
A unique type of medical organization exists in the ATC, the largest combined overseas and domestic organization that is controlled from a central headquarters in the United States. Command authority is divided into 10 divisions, 1 domestic and 9 foreign, which derive their names from the geographic locations which they cover.

Several of the more widespread divisions are further subdivided into wings, thus permitting a closer supervision of base level activities. Each division has a division surgeon who is responsible through his commanding general to the surgeon of the ATC. Each wing has a wing surgeon, who, in turn, is responsible to the division surgeon. Overseas and in the United States the ATC is no longer organized into groups and squadrons, but into numbered AAF base units. These units are one echelon beneath the wing or the division, as the case may be. Each base unit has its own surgeon and medical installation, the size depending on the work load.

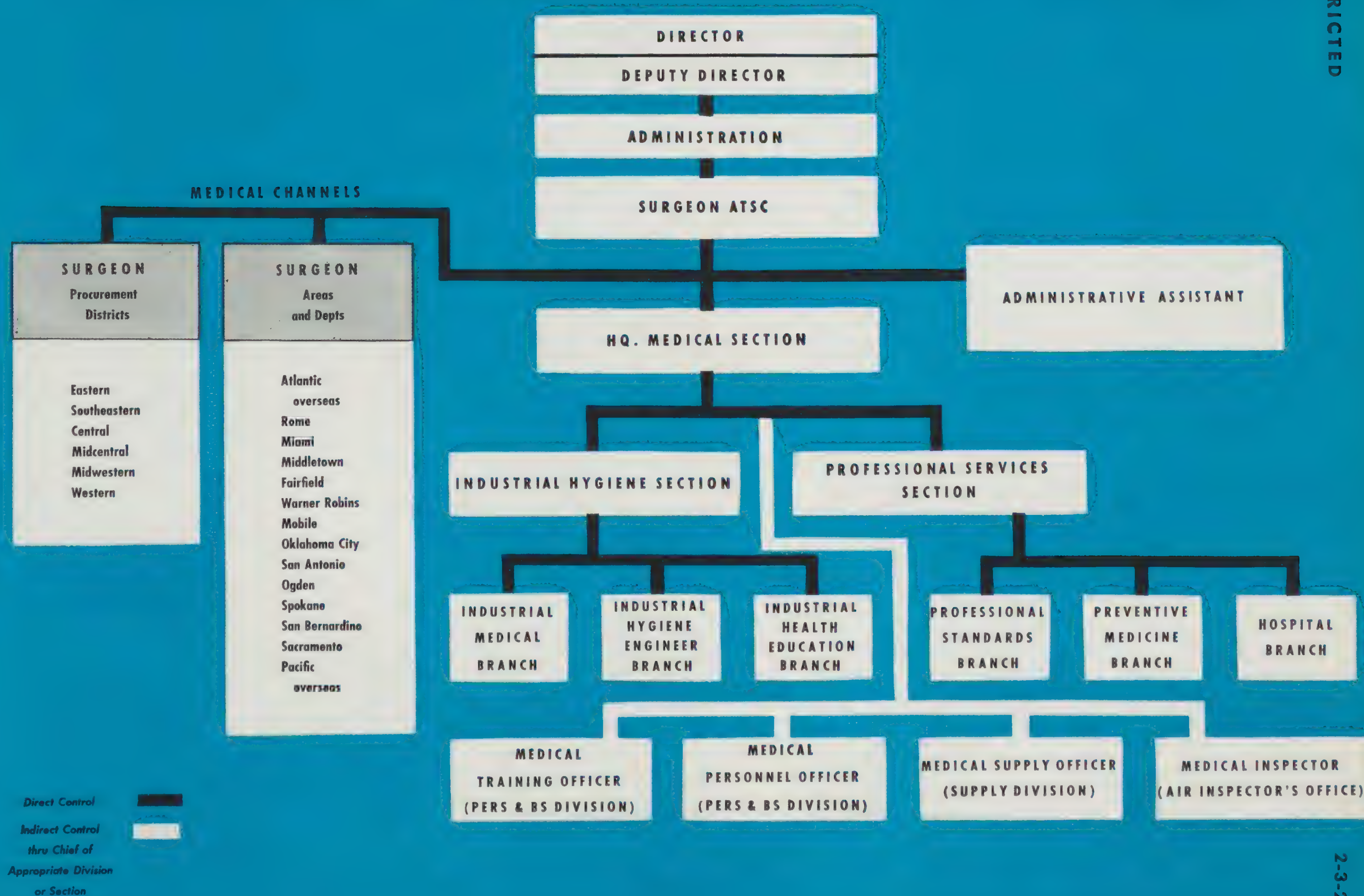
The ordinary Medical Air Evacuation Squadron did not lend itself well to the ATC method of operation. Under the supervision of The Air Surgeon, a new type, the 830th Medical Air Evacuation Squadron, was organized. It was composed of 56 flights, instead of the usual 4, having 1 central headquarters instead of 1 for every 4 flights, a conservation of 434 individuals. This organization has elasticity through central control and the capacity for rapidly reassigning flights on very short notice to areas where they are most needed.

A flight is composed of 1 flight surgeon, 6 flight nurses, and 8 Medical Department technicians. Each flight is further subdivided into evacuation teams, composed of 1 flight nurse and 1 Medical Department technician, who normally are the attendants for 1 aircraft load of patients. A flight surgeon or an additional Medical Department technician may also accompany a plane load of patients if it is deemed necessary.

AIR TRANSPORT COMMAND MEDICAL ORGANIZATION



MEDICAL SERVICE OF THE AIR TECHNICAL SERVICE COMMAND



AIR TECHNICAL SERVICE COMMAND

The organization of the surgeon's office, Air Technical Service Command, and his relation to the surgeons of procurement districts and areas and depots are shown in the charts.

Medical Section of the Air Depot Group or of the Service Group

In lower echelons such as the air depot group or the service group the functional medical unit is called the *medical section.* Normally, the medical section of each squadron of each air depot or service group will operate its own dispensary. Under combat conditions, the dispensary is known as an *aid station.* This change is largely functional to permit the rapid evacuation of casualties to the rear.

The medical sections of headquarters and headquarters squadrons of air depots and service centers are larger than those of repair, supply, or service squadrons. This is necessary because the men of the allied branches (quartermaster, ordnance, etc.) receive their medical care at the headquarters medical installation which is known as the *group dispensary* or the *group aid station.* The medical installations of the supply, repair, and service squadrons are known as *squadron dispensaries* or *squadron aid stations.*

Industrial Hygiene Section of the Air Depot

The Industrial Medical Program of the U. S. Army was originated and designed primarily to augment the required Civil Service medical facilities during the national emergency.

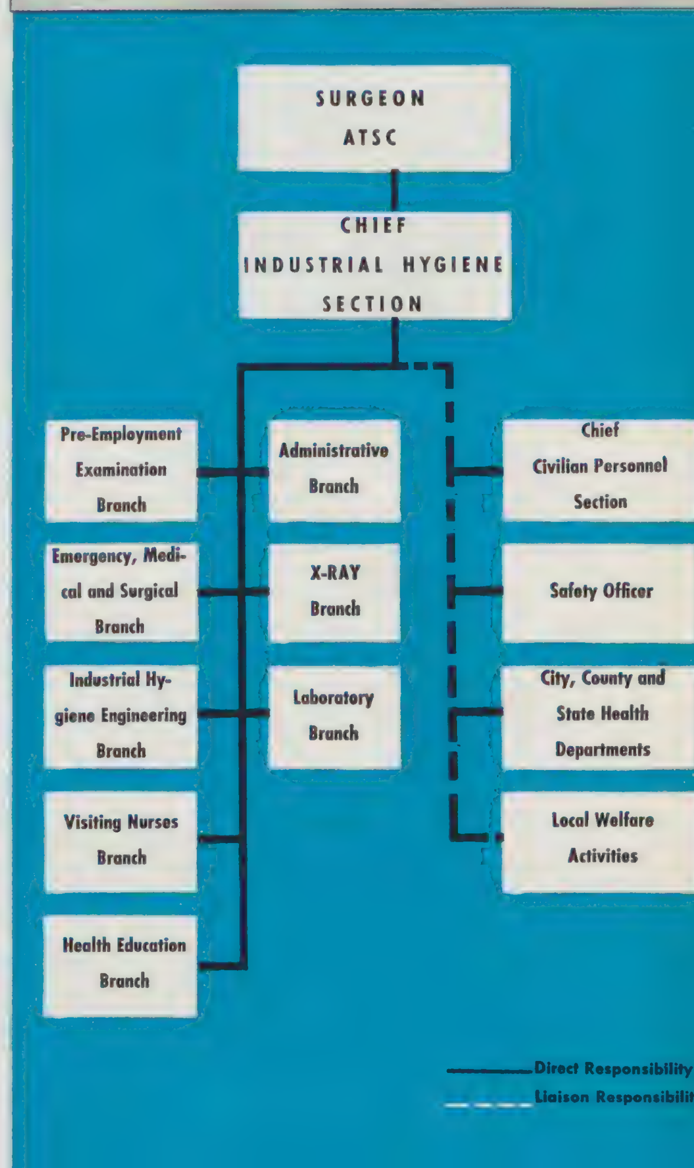
The Industrial Medical Program of the U. S. Army is broadly under the direction of the Surgeon General. In the AAF it is more specifically the responsibility of the Commanding General, AAF, and is applicable not only to all continental independent commands but also to the air depots operated by the Air Technical Service Command and to the many subdepots operated throughout the AAF.

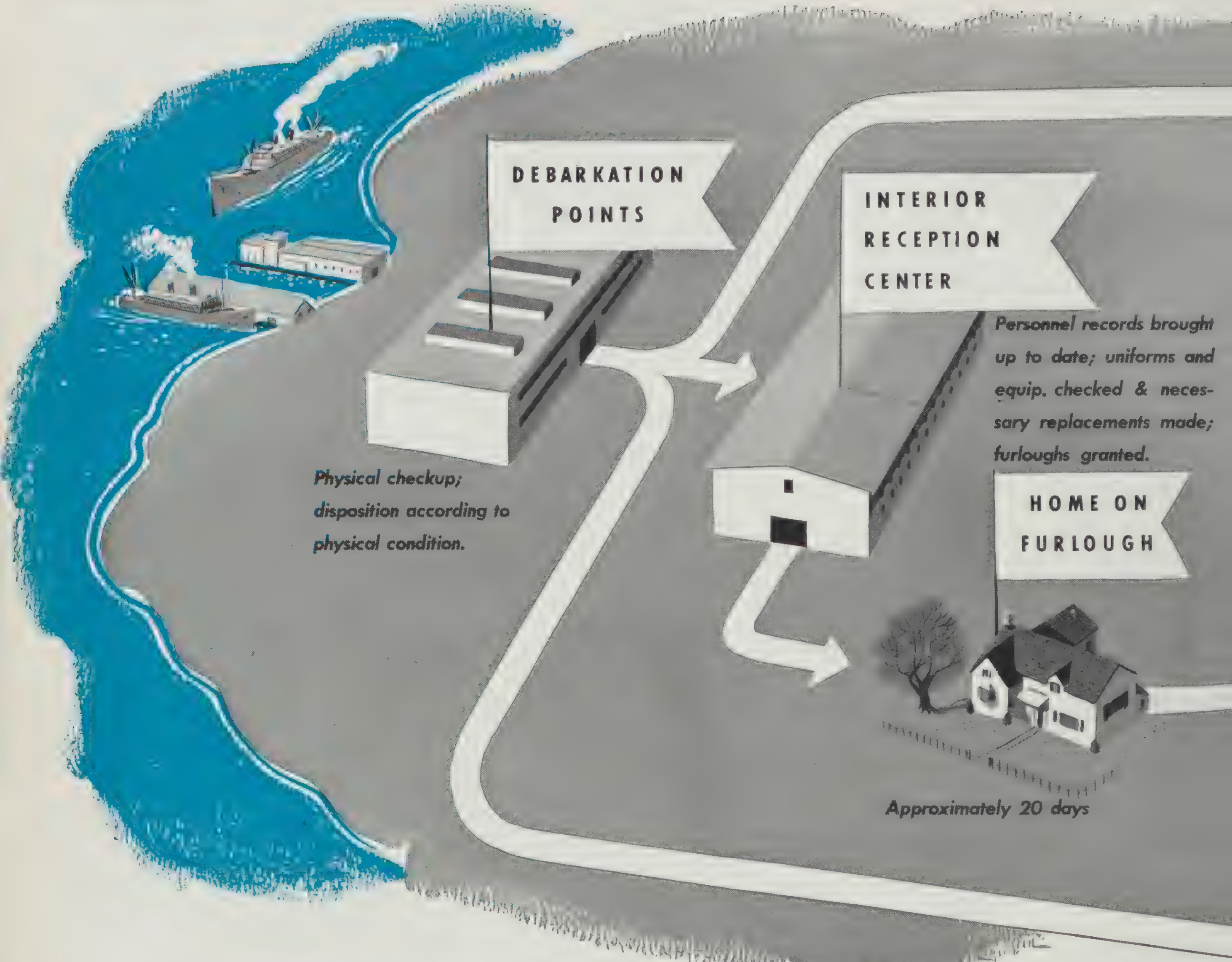
Because the Air Technical Service Command is the largest industrial organization in the world and hires more civilian employees than any other military organization, a separate Industrial Hygiene Branch has been set up under the direction of the surgeon, Air Technical Service Command, the chief of which is charged with supervisory control of the program throughout the AAF. Duties of the chief may be found in WD Circular 198, 20 May 1944.

REFERENCES

ATSC Reg 20-16, Organization of the office of the surgeon, Air Technical Service Command, 1 Sep 1944.
T/O & E 1-857, Depot repair squadron 15 Dec 1943.
T/O & E 1-858, Depot supply squadron, 25 Nov 1943.
T/O & E 1-852, Hq. and hq. squadron, air depot group, 20 Jan 1944.
T/O & E 8-497, Medical supply platoon, aviation, 26 July 1943.
T/O & E 1-417, Service squadron, 2 Jan 1944.
T/O & E 1-412, Hq and hq squadron, service group, 16 June 1943.
WD Circ. 198, Industrial medical program of the U. S. Army, 20 May 1944.
WD Circ. 242, Medical program, industrial, U. S. Army, 14 June 1944.

FUNCTIONAL ORGANIZATION OF TYPICAL INDUSTRIAL HYGIENE SECTION OF AN AIR DEPOT, ZONE OF INTERIOR



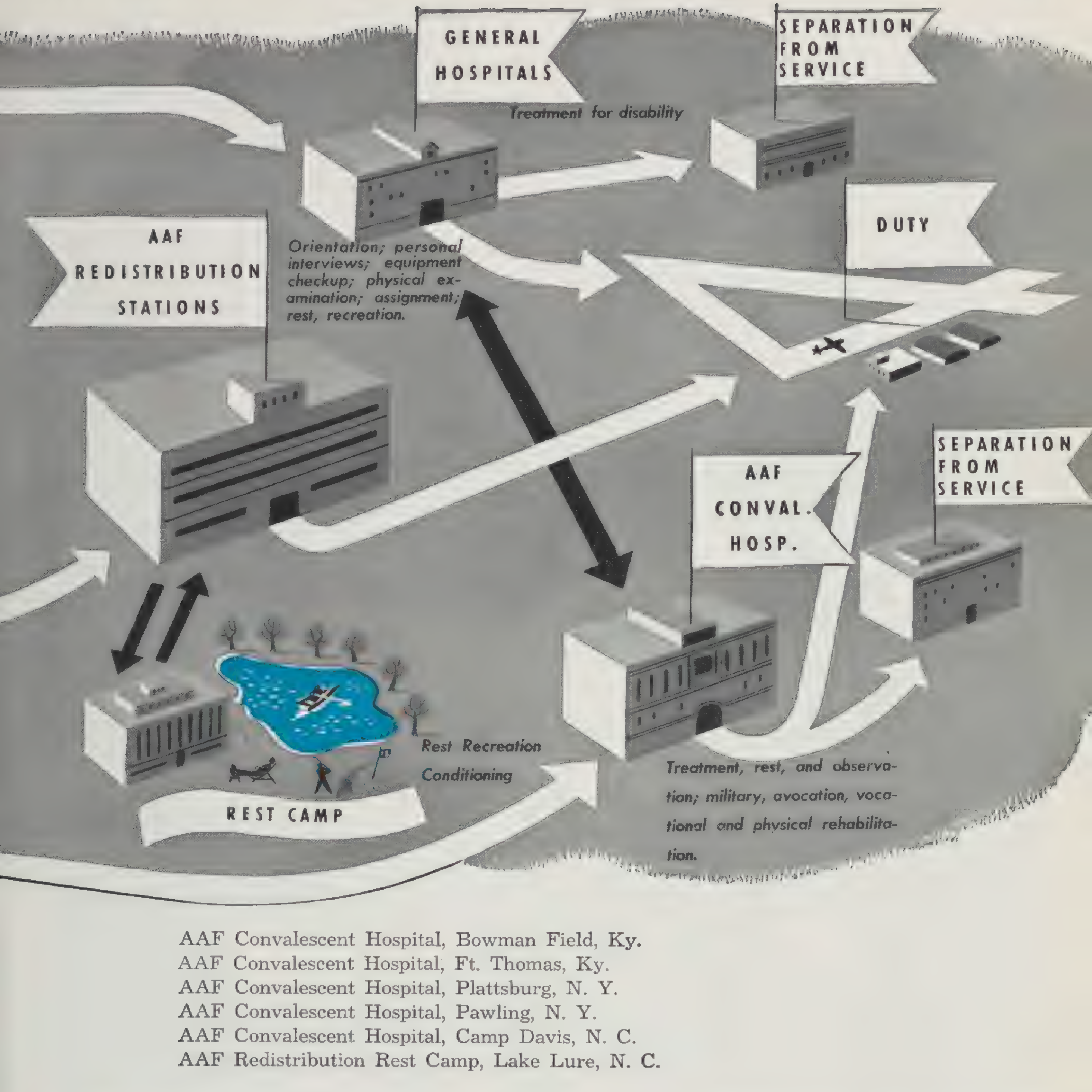


FLOW OF AAF PERSONNEL RETURNED FROM OVERSEAS

PERSONNEL DISTRIBUTION COMMAND

Installations of the Personnel Distribution Command are:

- AAF Redistribution Station No. 1, Atlantic City, N. J.
- AAF Redistribution Station No. 2, Miami Beach, Fla.
- AAF Redistribution Station No. 3, Santa Monica, Calif.
- AAF Redistribution Station No. 4, Santa Ana, Calif.
- AAF Overseas Replacement Depot, Greensboro, N. C.
- AAF Overseas Replacement Depot, Kearns, Utah.
- AAF Convalescent Hospital, Santa Ana, Calif.
- AAF Convalescent Hospital, Ft. George Wright, Wash.
- AAF Convalescent Hospital, Ft. Logan, Colo.
- AAF Convalescent Hospital, Richmond, Va.
- AAF Convalescent Hospital, St. Petersburg, Fla.
- AAF Convalescent Hospital, Miami Beach, Fla.



AAF Convalescent Hospital, Bowman Field, Ky.
AAF Convalescent Hospital, Ft. Thomas, Ky.
AAF Convalescent Hospital, Plattsburg, N. Y.
AAF Convalescent Hospital, Pawling, N. Y.
AAF Convalescent Hospital, Camp Davis, N. C.
AAF Redistribution Rest Camp, Lake Lure, N. C.

Medical dispensaries are maintained by the surgeon at each redistribution station for the purpose of providing medical care for permanent party personnel. At Station No. 1, those requiring hospitalization are referred to the England General Hospital located in Atlantic City; at Station No. 2 hospital facilities are available at the Convalescent Hospital in Miami Beach; at Station No. 3 permanent party personnel requiring hospitalization are temporarily transferred to AAF Regional Hospital at Santa Ana.

Each Redistribution Station has a dental clinic which provides adequate dental care for both returnee and permanent party personnel.

Returnees at Redistribution Stations who require definitive or convalescent treatment are referred to the AAF Convalescent Hospital nearest the station.

TRAINING COMMAND

Mission

The missions of the medical services of the AAF Training Command are several:

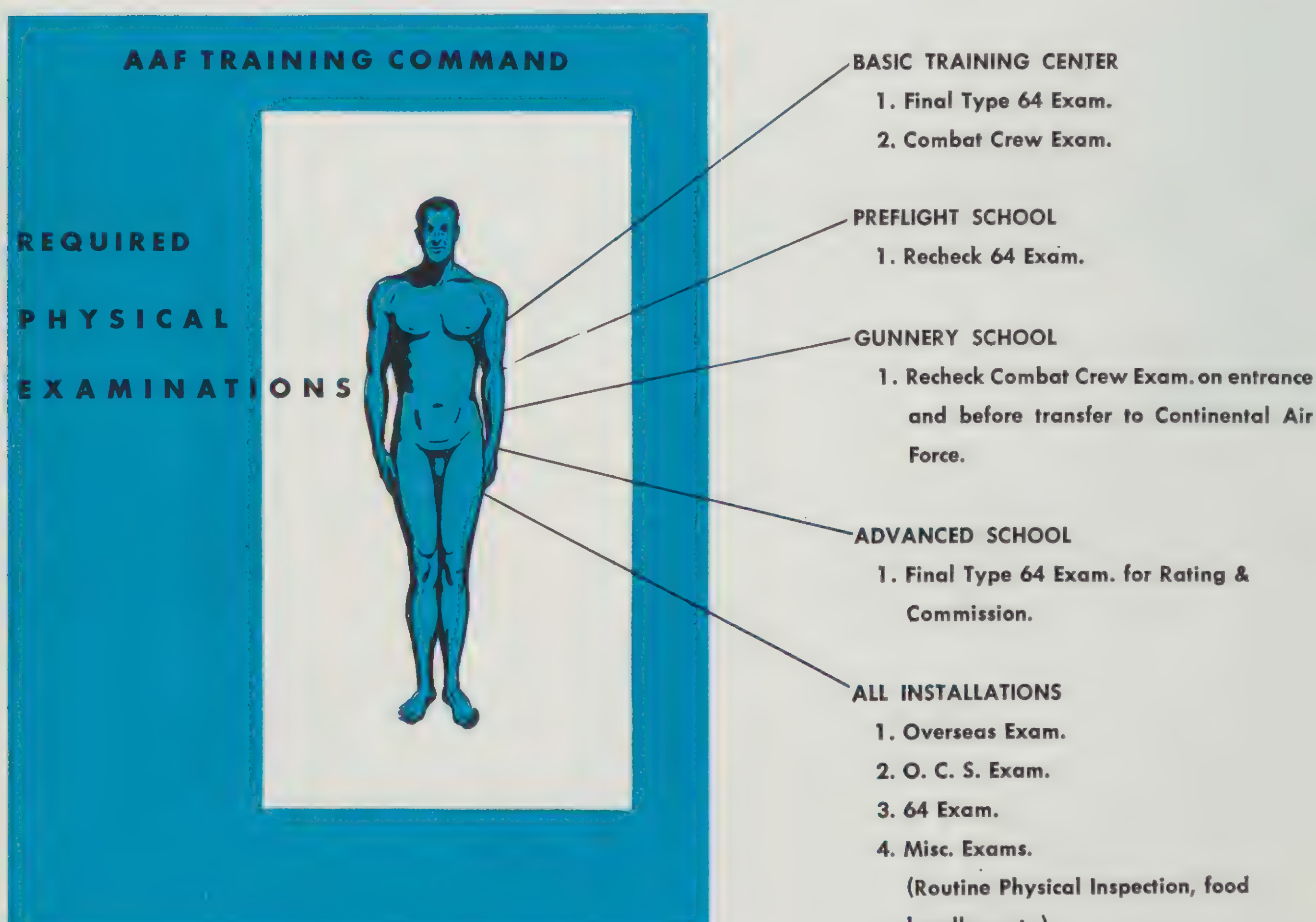
The physical selection and classification of trainees. Various types of physical examining services have been established at different levels of training within the command. At the Basic Training Centers there are medical and psychological examining services for the selection and classification of future pilots, bombardiers, navigators and aerial gunners. In addition, there are combat crew examining services which screen all personnel coming into the AAF to determine whether they are physically qualified for certain types of training for flying or ground duties ("combat crew examination").

There are expanded flight surgeon's units at the preflight schools which recheck the physical status of personnel entering preflight school. At the advanced flying schools all potential graduates are completely re-examined to determine their physical qualification for an aeronautical rating and appointment as a flight officer or commission as a second lieutenant. At the gunnery schools, all trainees are examined on arrival to determine their physical qualification for flexible gunnery training. This examination is repeated just before the flyer is graduated.

At all installations, personnel must be examined from time to time to determine their physical qualification for overseas duty.

Medical care of the command. This is accomplished through the medium of Medical Department personnel assigned to Regional and Station Hospitals.

Miscellaneous functions. The Medical Department is responsible for the *medical training* of AAF personnel as well as assigned Medical Department personnel and for the initial phases of *altitude training* for all flying trainees (see Section 10-3).



The *sanitation* of every facility is the direct responsibility of the base commander. Post sanitary inspectors under the direction of the post surgeon actually accomplish this function.

Medical research is largely of the applied type and directed toward problems that are of immediate concern to the accomplishment of the general training mission.

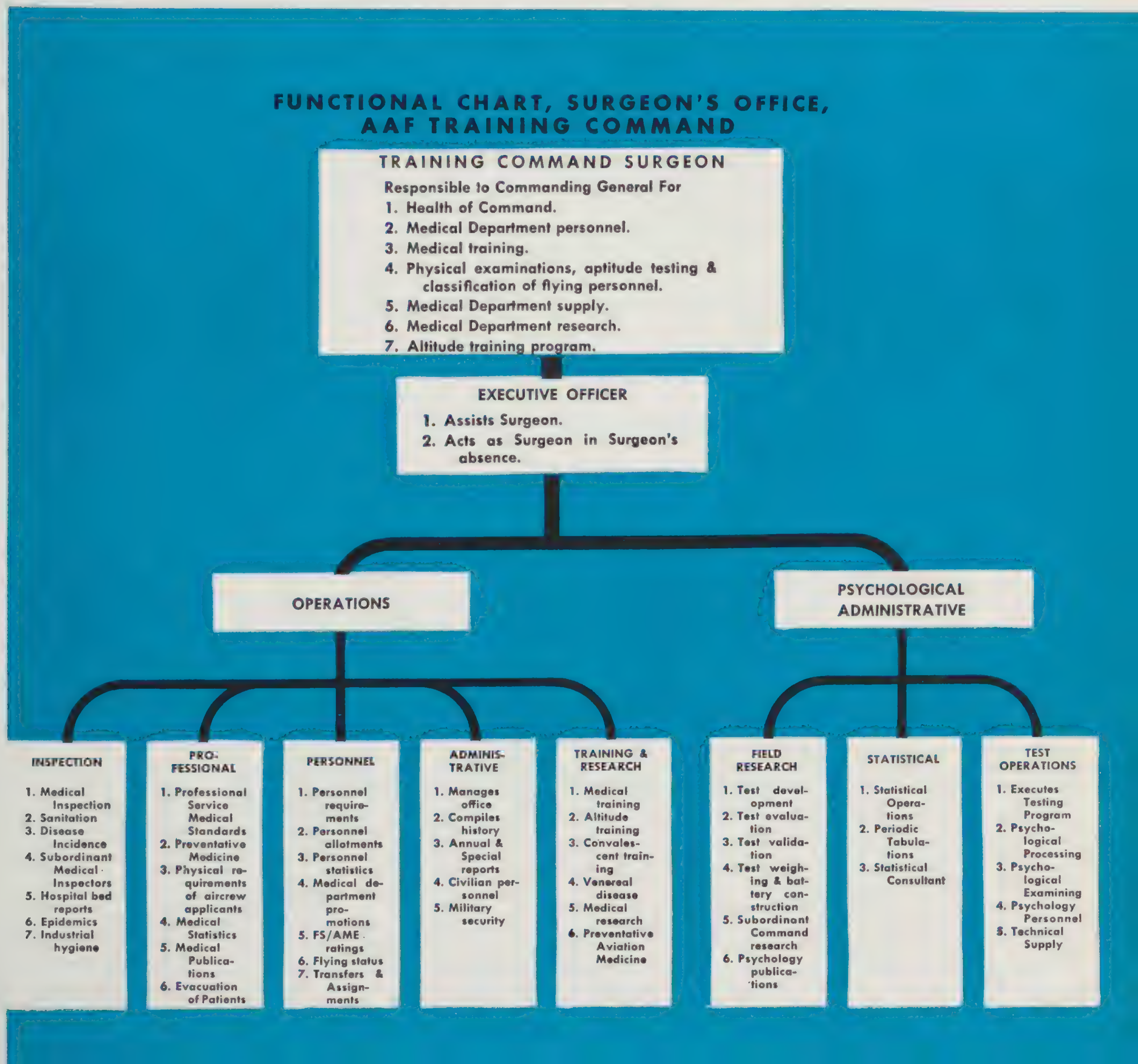
Organization

The Medical Department is organized and functions in the following manner.

In the Headquarters, AFTRC, the surgeon's office is organized and functions as depicted in the chart shown below.

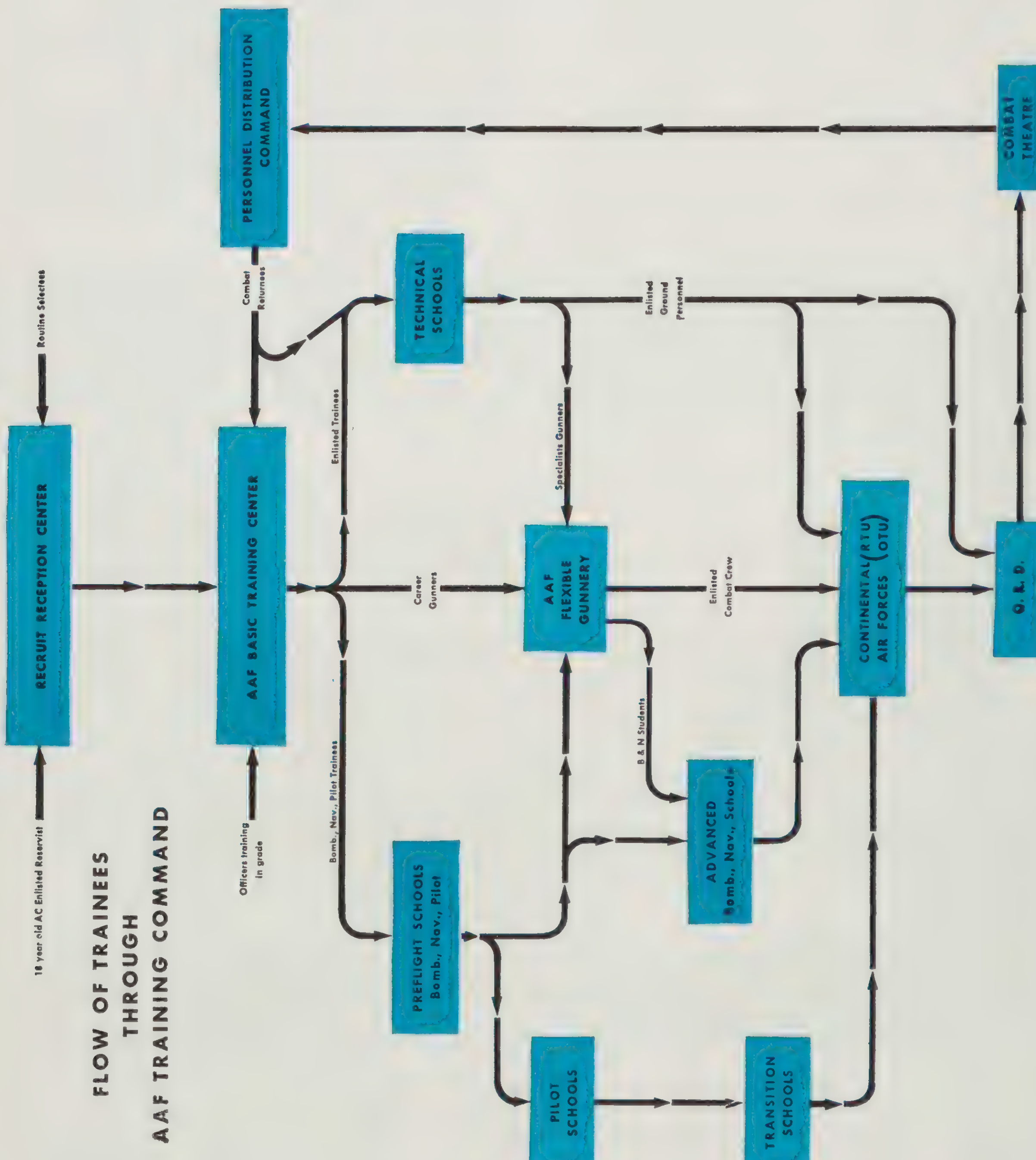
Subordinate to the Training Command surgeon are command surgeons at each headquarters of the five subordinate commands, viz., Eastern, Central and Western Flying Training Commands and the Eastern and Western Technical Training Commands. These medical sections function much the same as does the medical section of the headquarters of the AFTRC. Each command surgeon is responsible to his commanding general and to the Training Command surgeon for the medical portion of the mission of the subordinate command.

Directly under each command surgeon are the individual post surgeons in each command. Each post surgeon is responsible to his base commanding officer and to his command surgeon for the medical portion of the mission of the base.



The Flow of Trainees Through the Training Command

The sources of trainees entering the Training Command will vary according to requirements. The usual flow through the command is shown in the chart.



AAF Basic Training Center. Upon arrival at an AAF Basic Training Center, all men except officers are first examined at a physical screening station to determine their physical qualifications for combat crew training. This information must be entered on the service record. Those men who cannot qualify for physical reasons, or who are obviously unsuited for flying duties, are disqualified from all types of flying training and further classified as physically qualified or not physically qualified for overseas duty. These examinees are retained in the AAF for training in ground crew or basic duties.

All men, except enlisted men already fully classified and officers training in grade, are given the AAF technical tests under the direction of the Adjutant General's Department. The purpose of these tests is to classify completely all new members of the AAF according to their respective skills and aptitudes. This information is entered on the WD AGO Form 20 for future reference.

All personnel who are earmarked for training as a pilot, bombardier, or navigator are then processed through the *Medical and Psychological Examining Service.* This service is a part of the medical section of the AAF Base Unit.

1. Medical Examining Service. The purpose of this service is to conduct the physical examination for flying. The "64" examination is done over a period of 2 days. Medical rechecks are done on subsequent days when indicated.

Those examinees who present problems in diagnosis that cannot be decided in this facility are admitted to the hospital for further study.

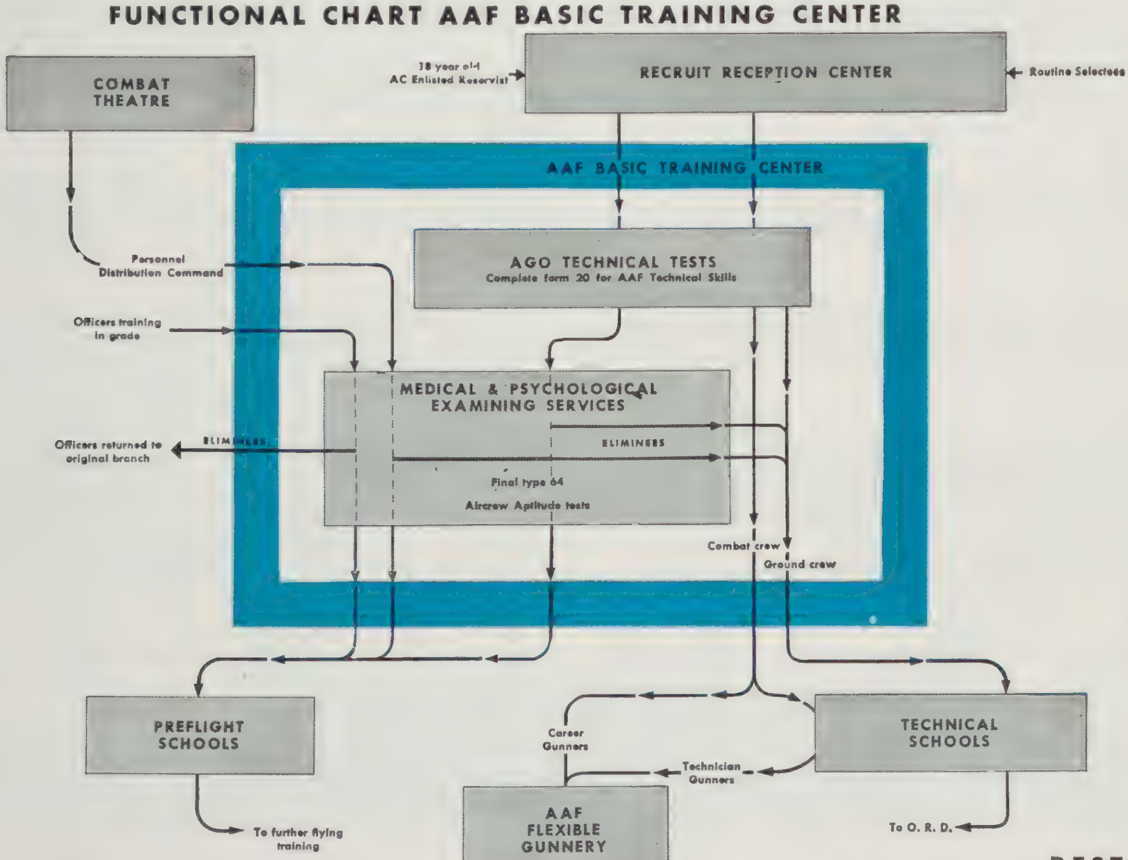
2. Psychological Examining Service. The purpose of this service is to conduct the aircrew aptitude tests (see Section 7-5). Two days are required for the group tests and the psychomotor tests. The group tests consume about 6 hours, the psychomotor tests about 2 hours.

On-the-line training. The pilot, bombardier, and navigation trainees, after completing basic training, are sent to "on-the-line" training at various flying schools to become oriented further in their future role in the AAF.

Preflight school. At the preflight school, the pilot, bombardier, and navigation trainees are given a recheck "64" examination. They are also given the first course in the Altitude Training Program and a night vision test.

Subsequent schools. Upon completion of preflight instruction, subsequent schools attended will depend upon the type of training the individual is to receive.

FUNCTIONAL CHART AAF BASIC TRAINING CENTER



Elimination from Flying Training

If the student is eliminated during the course of training as bombardier, navigator, or pilot, he may be re-assigned to one of the other two remaining types of training, provided he has not been eliminated for:

1. Disciplinary reasons;
2. Fear of flying;
3. Persistent airsickness;
4. Apprehension or tenseness;
5. At own request;

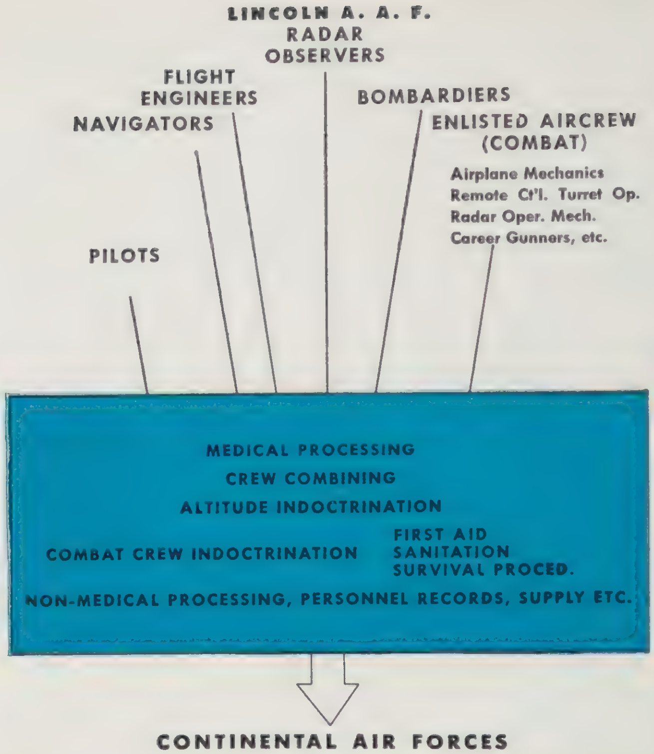
and is physically qualified for further aircrew training.

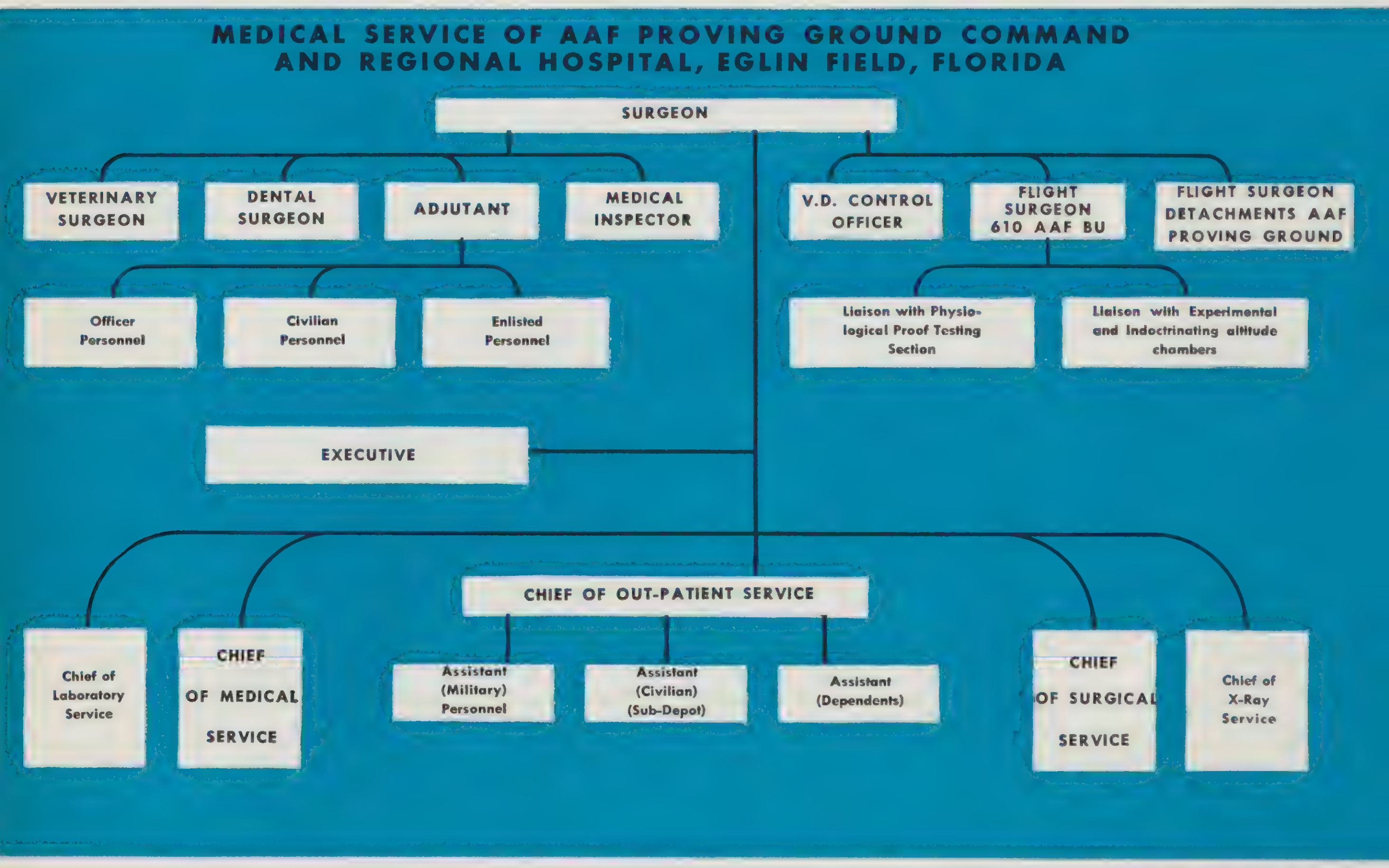
REFERENCES

TC Memo 35-22, Personnel, military, 27 June 1944.

Combat Crew Processing and Distribution

After completing one of the several types of flying training, graduates are ordered to Lincoln Army Air Field for final processing before being assigned to the Continental Air Force.





AAF CENTER

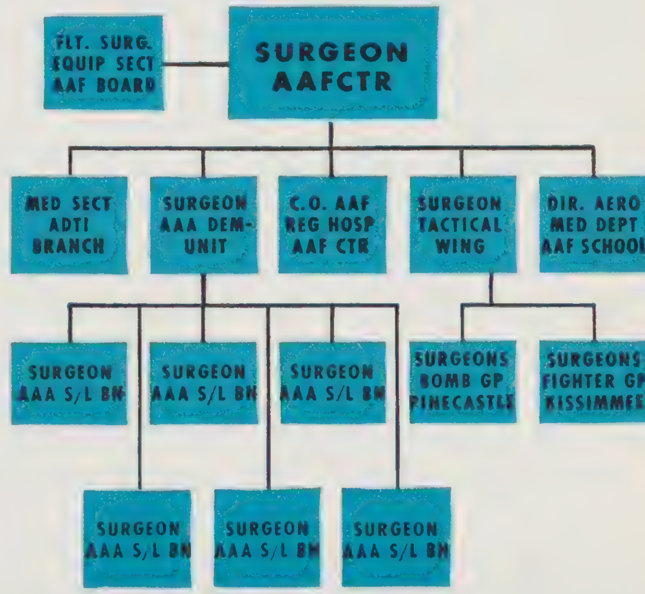
The mission of the AAF Center is to test new and different tactics and techniques of aerial warfare under simulated combat conditions; to test organizations, materiel, and equipment used or proposed for use by the AAF for operational and tactical suitability under simulated combat conditions; to instruct personnel of the Army and Navy, as assigned, in AAF tactics, techniques, doctrine, and organization; and to collect, evaluate, and disseminate information bearing on AAF activities in arctic, desert, and tropic regions.

This testing of organizational systems has resulted in frequent reorganizations of the whole command and consequently of the Medical Department, so that any detailed description of the medical organization is soon rendered obsolete. The basic plan, however, has remained essentially unchanged. There is always a chief surgeon, corresponding to an air force surgeon; a Director of the Aero Medical Department of the AAF School; wing or department surgeons with subordinate group and squadron surgeons; a surgeon of the Regional Hospital in Orlando; and surgeons of 12-bed dispensaries at each of the satellite air fields which have ranged in number from 12 to 2.

The surgeon, AAFCTR, is technically responsible for all the Medical Department activities of the command, and is a member of the Air Staff of the Commanding General.

The director of the Aero Medical Department, AAF School, is responsible for the instruction of students, both Medical Corps and Air Corps, in all phases of aviation medicine, and for the operation of the altitude training unit (see Section 2-5).

The wing surgeon is staff medical officer for the commanding officer of the tactical wing and acts in a supervisory capacity to the group flight surgeons. All tactical flying organizations, which perform simulated tactical missions for the AAF Board (see Section 2-7) are assigned to one of two groups, a bombardment group or a fighter group, and are located at one of the two outlying bases. There is a 12-bed dispensary at each base which, under the present test organization, is operated by the group surgeon who acts also as post surgeon. There are no Medical Department personnel assigned to the individual squadrons, except the bombardment squadron, very heavy. Instead, all medical personnel are assigned to the facilities squadron of the group and assist in the operation of the group dispensary and aid stations on the flying line. This experimental organization, i.e., assigning all medical personnel to the group and not to individual squadrons, is designed to conserve Medical Department personnel and to avoid unnecessary reduplication of effort.



MEDICAL SERVICE IN AAF CENTER

The tactical wing also includes an air warning squadron and a fighter control squadron which have numerous small units scattered throughout a 100-mile radius of Orlando. Each unit has a well-trained aid man who handles minor cases. Personnel requiring hospitalization are evacuated to the AAF Regional Hospital, Orlando, Florida.

The commanding officer, AAF Regional Hospital, AAFCTR, operates an 800-bed Regional Hospital and 6 dispensaries in the AAFCTR area. The chain of evacuation is: aid station to dispensary to hospital. Patients at satellite fields who require less than 3 days hospitalization are retained in the dispensaries.

The surgeon of the Anti-aircraft Artillery Demonstration and Training Unit is a staff medical officer for the commanding officer of that organization which is responsible for the training of Coast Artillery Searchlight Battalions, AGF units which are stationed temporarily at AAFCTR for a 2 or 3 months period of practical field training.

The AAF Board is located at AAFCTR (see Section 2-6).

The Arctic, Desert, and Tropic Information Branch has a medical section which collects, evaluates, and disseminates medical information (see Section 2-6).

MEDICAL SERVICE OF AN AIR FORCE

In the Theater of Operations

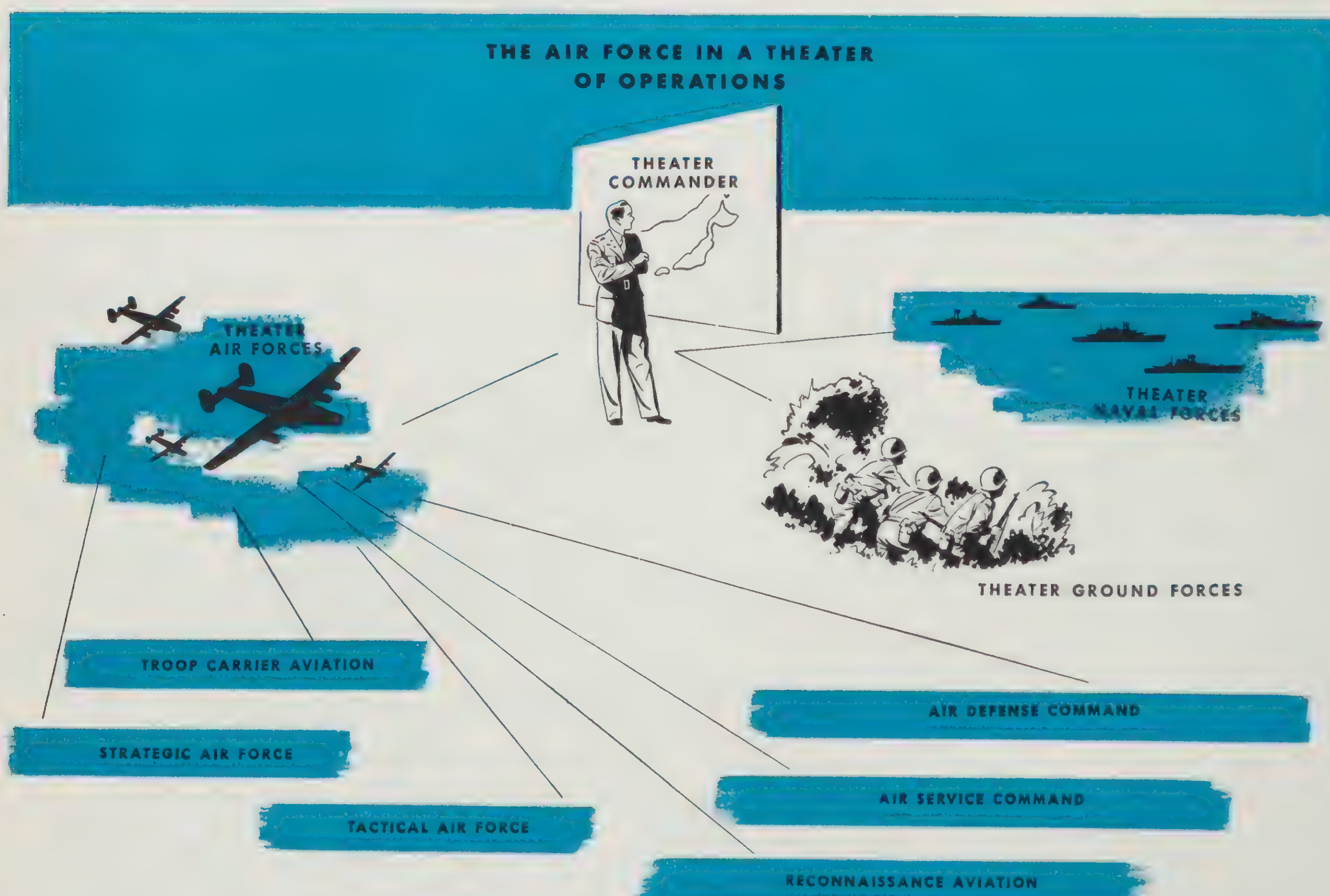
In a theater of operations there is normally one air force organized in accordance with the task it is required to perform. Although no rigid organization can be prescribed, it is intended that the normal composition of an air force will embrace:

A strategic air force.
A tactical air force.
An air defense command.
An air service command.

An air force usually includes, in addition, troop carrier and reconnaissance aviation units. The mission to be given to an air force determines in large measure the structure of the various commands and the actual assignment of fighter, bomber, and service units to each of them. Whether the air force is to operate under this type of setup or as a smaller air task force with a lesser number of groups, the medical service is basically the same.

Air Force Surgeon

The air force surgeon is a special staff officer of the air force commander, charged with keeping the commander informed as to the conditions and capabilities of the medical service and with elaborating the details necessary to carry out the commander's decisions as they affect medical matters. The general responsibility of the surgeon is to provide medical, sanitary, dental and veterinary service for the command. This includes such diverse activities as: maintaining the health, physical fitness, and medical training of all personnel; supervising the assignment, records and reports, training, supply and technical operations of Medical Department personnel and units including hospitals; supervising air evacuation of patients and the operation of air evacuation units; conducting aero-medical research and maintaining rated flying personnel at maximum physical and mental efficiency.



Air Force Surgeon's Office

Sections of the surgeon's office vary to some degree, depending upon the size and mission of the air force. In the large air force the office of the surgeon normally has the following sections:

Administrative Section. Ordinarily the executive officer is charged with the operation of this section, as well as the general conduct of the air force surgeon's office, and acts for the surgeon in his absence. It is concerned with advising the surgeon; directing and coordinating the work of the office; securing classified documents that come in; preparing orders, consolidated reports, policies, and answers to correspondence; maintaining current maps of installations in the theater.

Professional Section. This section normally consists of 4 or more officers, including a medical inspector, veterinarian, dental officer, and venereal disease control officer. It is directly concerned with the health of the air force. Health is maintained by: supervising preventive measures such as food inspection, immunization, and venereal disease control; reviewing such records as the physical examination for flying, care of flyer reports, Medical Officers Report of Aircraft Accident, statistical reports, dental reports, reports of disposition boards; maintaining liaison with local health departments and with the flying safety officer; and supervising the dental and nursing services.

Plans and Training Section. This section consists of one or more officers. It has the responsibility of providing efficient medical service for the air force by collecting medical intelligence data, formulating plans, making inspections and surveys, and making proper recommendations to the air staff. It also supervises all medical training.

Personnel Section. This section normally consists of one Medical Administrative Corps officer. It is concerned with assignment, transfer, and replacement of all Medical Department personnel, and reviews recommendations for promotions of officers.

Combat Command Surgeon

(Surgeon of the Strategic Air Force, Tactical Air Force, or Air Defense Command)

The combat command surgeon is directly responsible to the commanding general of the command for all medical matters pertaining thereto, and also to the air force surgeon for technical and professional matters.

Surgeon of the Air Service Command in an Air Force

The surgeon of the air service command is responsible to the air force surgeon for supervision of the medical supply operations of the particular air force. He is directly responsible to the commanding general, air service command, for the medical service of that command. In addition to the usual medical duties, he supervises inspection of medical items received at air force depots, and advises the air force surgeon on supply requirements pertaining to the procurement, storage, and distribution of medical supplies and equipment for the entire air force.

The medical sections of the *air depot* and *service groups* of the air force air service command are similar to the medical sections of combat groups. These are staffed with officers and enlisted men who provide dispensary and supply functions. The equipment of each of the air depot and service groups is sufficient to operate a 36-bed dispensary. At this dispensary casualties are retained until evacuation to AGF or ASF installations can be effected. Minor cases are not evacuated if they can be returned to duty within a few days.

The *surgeons of air depot and service groups* supervise the medical activities of the group. They are directly responsible to the group commander for all medical matters pertaining to the command, and to the surgeon, air service command, for all technical matters.

Wing Surgeon

(Bombardment, Fighter, and Troop Carrier)

The wing surgeon supervises the activities of the medical personnel attached to wing headquarters squadron. He is directly responsible to the wing commander for all matters pertaining to command and administration of the medical section, and to the command surgeon for technical matters. Medical supply plans and specific evacuation plans for all operations are prepared and submitted for approval to the wing commander. Where a troop carrier command is not in operation in the air force, the wing surgeon of a troop carrier wing is responsible for matters pertaining to air evacuation.

Group Surgeon

(Bombardment, Fighter, and Troop Carrier)

The group surgeon supervises the activities of the group medical section. He is the senior flight surgeon of the group and is directly responsible to the group

commander on all matters pertaining to command and to the administration of the medical section, and to the wing surgeon for technical matters.

Squadron Surgeon

(Combat or Service)

The squadron surgeon's duties go far beyond mere professional care of sick and wounded personnel (see Section 1-1) and embrace many functions of an entirely advisory and administrative character. In his advisory capacity, the medical officer acts as a special staff officer for the squadron commander; in his administrative capacity he acts as commander of whatever enlisted medical personnel may be attached to the squadron.

Other Medical Sections and Units

Group and Squadron Medical Sections

The equipment of *group medical sections* is sufficient for the operation of a 36-bed dispensary. Normally, only those casualties which may be returned to duty within 10 to 14 days are held at group dispensaries. Personnel of the organic and attached squadrons of the group are utilized to staff the group dispensary.

In addition, five medical units peculiar to the AAF are provided as needed, the organization and functions of which are described below.

Medical Dispensary, Aviation

In addition to the attached medical sections, a medical dispensary, aviation, may be assigned to an air force command to provide a complete dispensary service at air bases where a hospital is not necessary. It can operate independently to provide essential medical service where adequate facilities are not otherwise available in the area.

This installation is normally a 36-bed unit with necessary hospital equipment. In addition to group dispensary equipment, (see Section 6-3), the dispensary has 4 quarter-ton trucks, 3 quarter-ton cargo trailers, and one quarter-ton 250-gallon water tank trailer.

The personnel is headed by the commanding officer, a flight surgeon, with one additional medical officer, one dental officer, one Medical Administrative Corps officer, and 24 enlisted men. A smaller dispensary, normally of 24-bed capacity with a reduced personnel of 3 officers and 13 enlisted men, has also been authorized.

The medical dispensary, aviation, provides:

For the retention, treatment, and preparation of serious casualties until evacuation can be effected by motor or air ambulance to a hospital installation in the rear.

For the treatment of minor casualties where hospitalization in an ASF or AGF hospital is not considered necessary or practical.

The unit may:

Act independently in providing dispensary service for one or more combat groups located at isolated airfields.

Act jointly with the medical section of a squadron or group to provide medical dispensary service.

Medical Air Evacuation Squadron

The medical air evacuation squadron provides medical personnel and medical equipment to operate with troop carrier and air transport command units in a theater for the air evacuation of casualties (see Section 4).

Central Medical Establishment

This air force unit is designed to provide a special aero-medical service in a theater. It furnishes facilities for special aero-medical training, consultation concerning medical problems relating to flight, and establishes medical review boards to investigate the medical status of air force personnel. It also serves an important additional function in providing personnel and facilities for the carrying forward of research problems of primary interest to the Commanding General, AAF (see Sections 2-6 and 3-3).

Medical Supply Platoon, Aviation

This is normally a part of an air depot group or an air force general depot. It requisitions medical supplies for air force units from theater medical depots. A medical supply level of 30 to 45 days is normally maintained, depending upon the logistical and tactical requirements. The medical supply platoon, aviation, directly supplies those air units supported by the air depot group or air force general depot of which it is a part.

The Veterinary Detachment, Aviation

This is a flexible, mobile organization designed to furnish veterinary services for a theater air force. The unit inspects all meat, food, and dairy products, provides care of all animals utilized by the air force, and accomplishes research concerning procedures for the extermination of rodents.

Hospitalization in the Theatre

(see Section 3)

Normally patients may be retained in air force dispensaries for a period of time determined by coordination with the theater commander. They provide treatment for minor casualties and for other non-effectives where hospitalization is not necessary.

Hospitalization in theaters of operation is the responsibility of the theater commander except: (a) In those cases where it is impractical for the theater commander to provide such medical installations for air force units; (b) when hospital facilities are provided directly to air force units by the War Department.

In such cases the Commanding General, AAF, is responsible for hospitalization of air force personnel. In many theaters of operations, hospitals are assigned or attached by the theater commander to the theater air force.

REFERENCES

FM 100-20, Command and employment of air power, 21 Jul 1943.

WD Circ. 48, Training in basic medical subjects, 3 Feb 1944.

AAF Ltr. 50-16, Medical training, 10 Mar 1944.

AAF Reg. 25-8, Gas defense and treatment program of air force establishments, 27 July 1942.

AAF Reg. 65-1, Supply and maintenance, 14 Aug 1942 (Supplemented by 65-28, 10 Jul 1943).

T/O and E 8-450, Medical dispensary, aviation, 27 Oct 1943.

T/O and E 8-450-RS, Medical dispensary, aviation (RS), 27 Apr 1944.

T/O and E 8-447, Medical air evacuation squadron, 19 Jul 1944.

T/O and E 8-497, Medical supply platoon, aviation, 26 Jul 1943.

T/O and E 8-487, Veterinary detachment, aviation, 25 Nov 1943.

In The Zone of Interior

(The Continental Air Force)

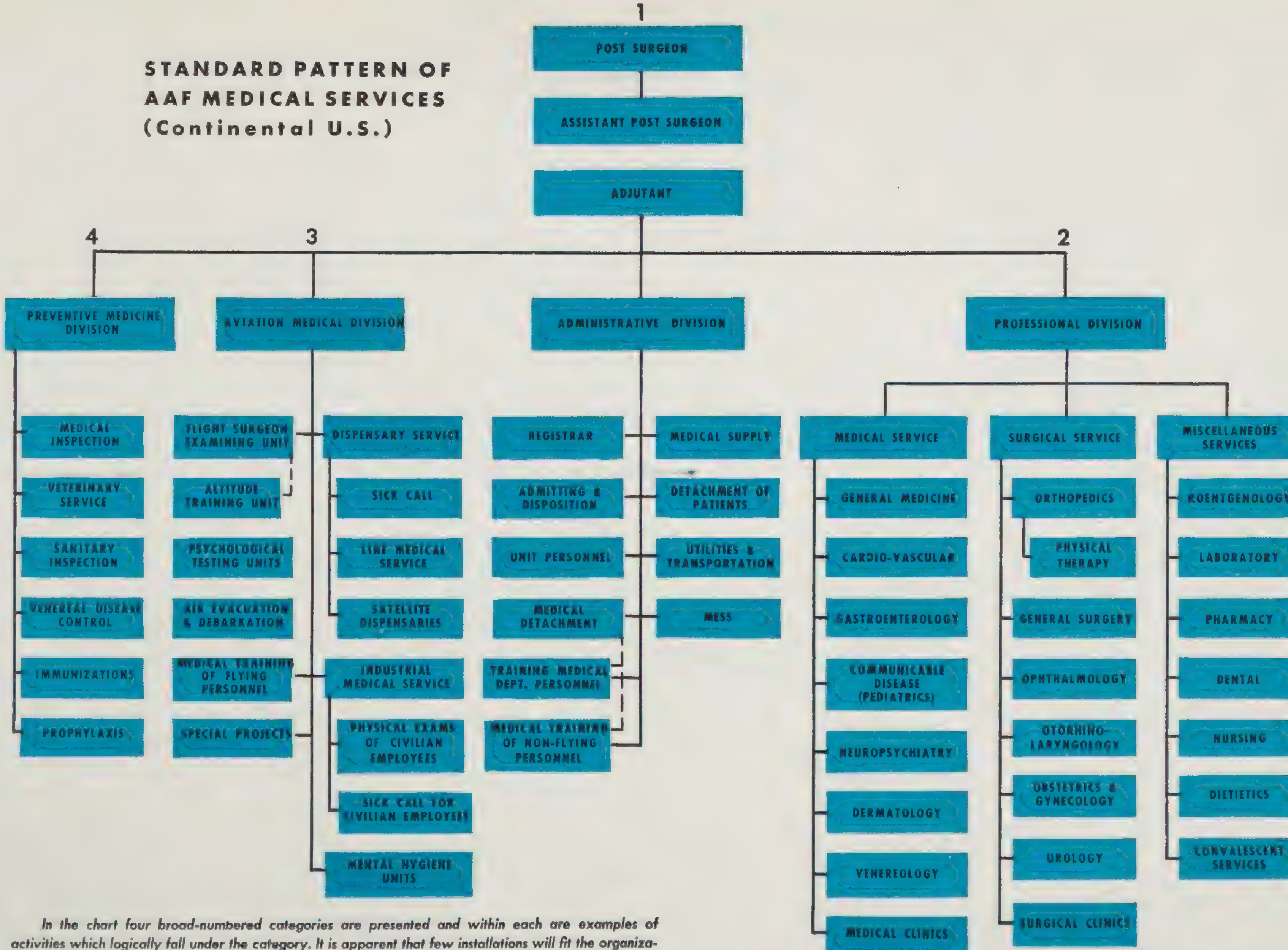
The principal function of the Continental Air Force is operational training and preparation of combat crews for replacement in tactical organizations. Subsidiary commands of the Continental Air Force are the First, Second, Third, and Fourth Air Forces, and the First Troop Carrier Command.

The medical service of the CAF is concerned not only with the usual medical functions but also with the medical processing and training of combat crews.

The medical organization includes a surgeon and medical section at Headquarters, Continental Air Force, Andrews Field, Maryland, and a surgeon and medical section at each of the headquarters of the 5 subsidiary commands.

The details of the medical service vary in each subsidiary command, depending upon the medical requirements of the command.

STANDARD PATTERN OF AAF MEDICAL SERVICES (Continental U.S.)



In the chart four broad-numbered categories are presented and within each are examples of activities which logically fall under the category. It is apparent that few installations will fit the organization as presented. A large and active station with a hospital of five hundred or more beds will approximate the guide. A small station providing nothing but dispensary service ordinarily will show only categories 1 and 3. Similarly, a headquarters medical staff section will show only category 1. In the case of convalescent hospitals a liberal interpretation of the chart must be made to provide for the numerous and divergent functions of such installations.

AAF SCHOOLS AND RESEARCH LABORATORIES

School of Aviation Medicine

Establishment and Control. The AAF School of Aviation Medicine had its origin in the Medical Research Board and Medical Research Laboratory which was established 18 Oct 1917 by The Adjutant General. On 19 Jan 1918, the Central Medical Research Laboratory, Hazelhurst Field, Mineola, L. I., began functioning. In November, 1919, the Medical Research Laboratory and School for Flight Surgeons moved to Mitchel Field, L. I. The laboratory and school was later recognized as a Special Service School and the name changed to the School of Aviation Medicine on 8 Nov 1922. On 30 June 1926, the school moved to Brooks Field, San Antonio, and on 30 Oct 1931 to its present location at Randolph Field, Texas.

The school is under the direct control of the Commanding General, AAF, and is supervised for the Commanding General by the Air Surgeon. It is not subject to the orders of the local commander except for court-martial jurisdiction, telephone and signal communications, routine repair and supply and maintenance, or as may be otherwise prescribed by the Commanding General, AAF. The commandant is authorized to communicate directly with the Commanding General, AAF.

In September 1944 the school was organized as the 27th AAF Base Unit and assigned to Headquarters, AAF.

Mission. The mission of the school is to instruct and train selected Medical Corps officers, assigned to the AAF, in the duties of a flight surgeon; Medical Department enlisted men, assigned to the AAF, in the duties of flight surgeon's assistants; selected AAF officers and enlisted men in the execution of the Altitude Training Program. It is also part of the mission to instruct and train students in the professional, technical, tactical and administrative procedures involved in the air evacuation of the sick and wounded; instruct and train army nurses assigned to the AAF in specialized aviation nursing; and to instruct and train other personnel of and assigned to the AAF in courses of instruction as may be directed by the Commanding General, AAF. It is part of the mission of the school to conduct research in aviation medicine and air evacuation (see Section 11-1) and to provide hospitalization, medical care and professional assistance to the commanding officer and personnel of Randolph Field.

Organization and Operation. The 27th AAF Base Unit is authorized strength and grades by Headquarters, AAF Exact Manning Table No. 27.

Training Program. The training program was developed by the commandant, subject to the approval of the Air Surgeon, so that the mission of the school might be accomplished. The courses given follow:

1. The aviation medical examiner's course covers a period of 11 weeks. Medical officers of the A.U.S. are taught to perform the special duties of an aviation medical examiner and to coordinate such duties with other professional and non-professional activities which they may be called upon to perform as medical officers. The course includes 10 hours of pilot training for eligible officers.

2. The course in aviation physiology is 5 weeks

SCHOOL OF AVIATION MEDICINE

RESEARCH LABORATORY, SCHOOL OF AVIATION MEDICINE

long with an interval of varying length between classes, depending upon the availability of students. The object of the course is to train aviation physiologists to operate the altitude chamber, administer the altitude training unit and to instruct flying personnel in the physiology of high altitude and in the use and maintenance of oxygen equipment (see Sections 1-4 and 10-3).

3. The flight surgeon's assistant's course covers a period of 6 weeks. It is designed to train Medical Department enlisted men in their duties as flight surgeon's assistants. This course was temporarily suspended as of 7 September 1944 (see Section 1-3).

4. Extension course. This course is designed to give theoretical instruction to Medical Officers of the Regular Army, National Guard, Reserve Officers and specially designated medical officers of foreign countries who are unable to attend a complete basic course in residence. The extension course is closed to new enrollment, except to specially designated foreign students.

5. Air Evacuation Department. Four courses are regularly given by the Department of Air Evacuation:

a. Chief nurses course covers a period of 4 weeks. The program is designed to familiarize the nurse with various phases of military nursing and nursing administration as well as to enable her to function in a supervisory capacity over Army Nurse Corps personnel. The training time is equally divided between classroom instruction and simulated experience.

b. The flight nurses course is 9 weeks and is divided into three phases: the first covers a review of medical and military subjects required of all military personnel; the second covers material peculiar to air evacuation; and the third is used for a bivouac period and actual evacuation flights within the zone of interior. The purpose of the course is to train AAF nurses in the theory and practice of air evacuation of sick, wounded and injured. It will also prepare them for assignment to ground medical installations when not engaged in evacuation duties.

c. The medical technicians course (air evacuation) runs 8 weeks. The enlisted men are trained in the evacuation of casualties by air, the nursing management of patients during flight, and the performance of hospital or aid station duties when not occupied with air evacuation. The course is divided into two phases: Phase A is 3 weeks in length and stresses subjects necessary to all men of the medical air evacuation squadron; Phase B covers a period of specialized training of 5 weeks, the last week being spent in training flights, field maneuvers and the practical study of transporting psychiatric patients. The medical technician for air evacuation takes the entire 8 weeks course.

d. The medical officers course. Graduates of the School of Aviation Medicine assigned to air evacuation duties are given 2 weeks special instruction in matters peculiar to the evacuation of patients.

e. Two weeks refresher course in medicine and surgery for medical officers who have had non-professional duties for long periods. This is followed by 10 weeks of ward instruction at an AAF Regional Hospital.

REFERENCES

AAF Reg. 20-27, AAF School of Aviation Medicine, 4 Dec 1944.

AAF Ltr. 20-42, Organization of the 27th AAF Base Unit (AAF School of Aviation Medicine), 18 Aug 1944.

Exact Manning Table No. 27.

AAF Reg. 20-42A, AAF School of Aviation Medicine, 2 Dec 1944.

The Aero Medical Laboratory

The Aero Medical Laboratory, founded in 1931, is one of five laboratories of the Aircraft and Physical Requirements Laboratory Section of the Engineering Division, Air Technical Service Command, Wright Field, Dayton, Ohio.

Its functions are to carry out research to determine the effect of flight on man and to recommend means of neutralizing or eliminating the deleterious effects which adversely influence the efficiency, health, or safety of flying personnel.

By memorandum, the Chief, Engineering Division, officially assigns certain broad, general duties for which the Aero Medical Laboratory is responsible. The branch concerned with a particular assignment then initiates an expenditure order outlining the project or projects which will satisfy the assigned requirement. When these plans are accepted by the Branch Chief, the Chief of the Laboratory, and the Chief, Engineering Division, necessary funds and personnel are allocated to make possible the project to be undertaken. Although the Chief, Engineering Division, officially outlines the responsibilities of this laboratory, the suggestions for the studies and experiments come from a variety of sources: from the Materials, Maintenance, and Distribution Section in Washington; from foreign theaters and domestic installations; from the Office of The Air Surgeon; from requests of other laboratories; and from ideas of members of this laboratory.

The Aero Medical Laboratory is divided into six branches: Biophysics, Medical Detachment, Medical Specialty, Oxygen, Physiological, and Service Liaison, each of which is further subdivided into units. The duties of each branch are as follows:

Biophysics Branch. Conducts research on problems in biophysics and engineering which concern aviation medicine. It designs and fabricates instruments and test equipment not available commercially which are best adapted to physical and biophysical measurements. Special projects of investigation include studies of spatial problems associated with production of aircraft, such as size, shape, and gross movements of the bodies of aircrew personnel in relation to the operating spaces providing safety and comfort. In the studies of personal flying equipment, the size and shape of oxygen masks and helmets and the evaluation of the principles used in the design of clothing are also included. High altitude protective methods, such as pressure breathing, pressure suits, and pressurized cabins, are studied. Remedial measures are developed to combat the effect of noxious gases encountered in aircraft. Visual activities include the design and development of all types of goggles required by air force personnel and the optical properties of the transparent sections used in aircraft. Supervision of the temperature control and ventilation methods in aircraft is also a responsibility of this branch.

Medical Detachment Branch. Initiates, records, and accounts all fiscal transactions of the laboratory, checks all authority for purchase orders, and maintains property records. It is responsible for the maintenance, repair, and policing of the laboratory buildings and equipment, and for the administration and welfare of enlisted personnel of the Medical Department detachment. Personnel concerned with drafting, supply, fabrication, repair, police activities, and transportation are under its immediate supervision.

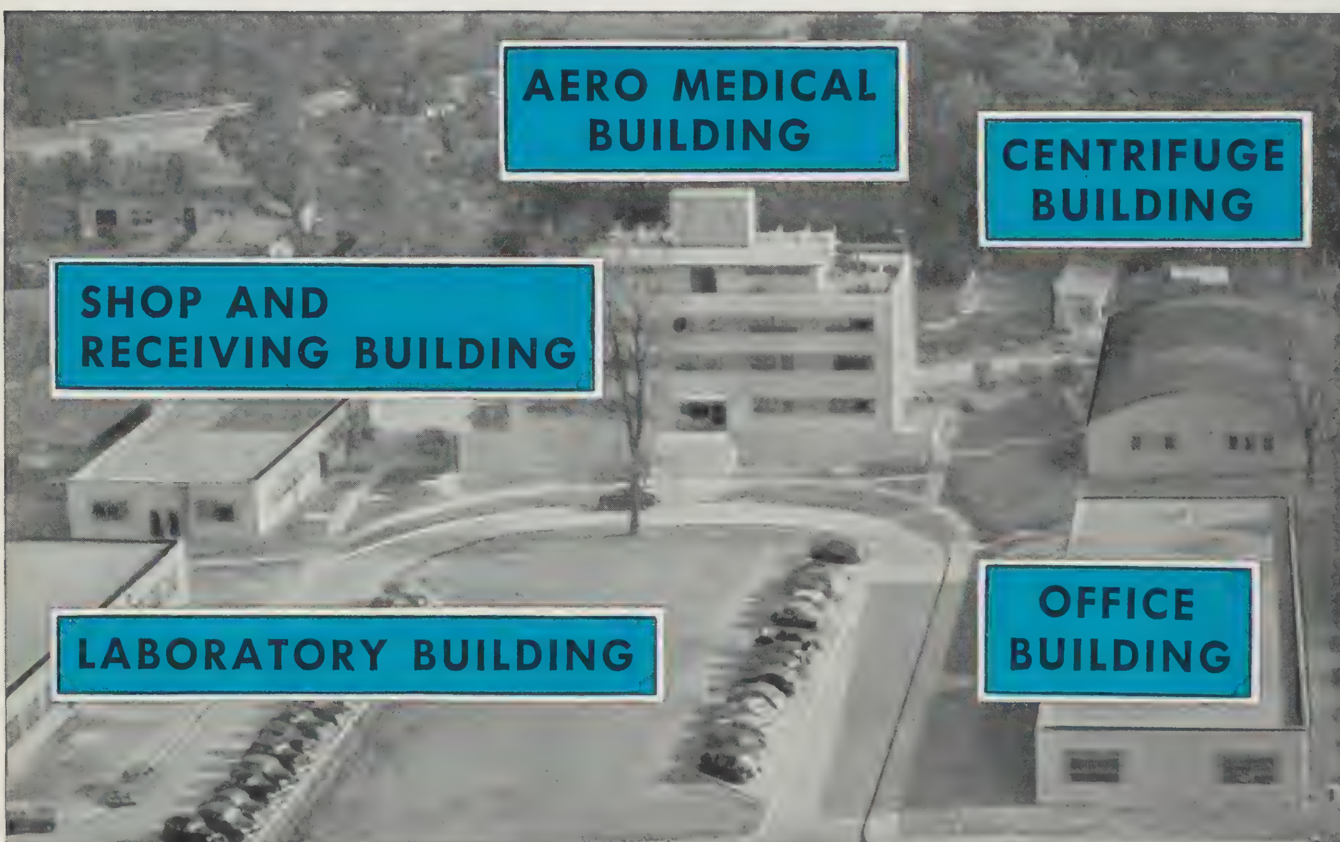
Medical Specialty Branch. Is concerned with medical problems peculiar to the AAF. Research on these problems includes the development and standardization of the following: equipment required for air evacuation of sick and wounded in airplanes, gliders, and helicopters; all medical kits and other medical equipment peculiar to AAF needs; dental equipment suitable for airborne and other highly mobile use by the AAF; and medical equipment for crash ambulances. Studies are made on wound ballistics and related protective devices.

Oxygen Branch. Is responsible for the research, development, and release for standardization of oxygen equipment for military aircraft and personnel. This includes oxygen masks, regulators, flow and pressure indicating devices, cylinders, distribution systems, emergency and accessory oxygen equipment, ground cylinders for storage of all gases, oxygen generating plants, cylinders and valves forming a part of welding equipment, and field testing equipment. Further studies and activities include the establishing of standards of purity and moisture content of breathing oxygen, oxygen requirements of flyers, instructive procedures and devices for training personnel in the use of oxygen equipment, flight testing of all items of oxygen equipment, development and release for standardization of inflation gear, cylinders for life rafts, and fire extinguishers for use in military aircraft.

Physiological Branch. Conducts studies in human physiology in relation to flight personnel, such as

basic oxygen requirements, the effects of acceleration, and related phenomena. It tests equipment designed for anti-g protection and devices for increasing the tactical efficiency of flight personnel. Studies are made of nutritional and water requirements during normal operations and in emergencies. Military and civilian personnel are indoctrinated in the effects of high altitude, and educational devices are developed for this purpose.

Service Liaison Branch. Collects and disseminates technical information related to the over-all program of the Aero Medical Laboratory and maintains liaison with other AAF activities. It is responsible for the publication of the Air Surgeon's Bulletin and reviews for editorial recommendations all publications, including manuals, pamphlets, posters, and proposed Technical Orders originating in the laboratory. Other functions consist of maintaining and operating all photographic and other reproduction equipment and preparing drawings and illustrations for all of the branches. This branch serves to maintain liaison with overseas theatres, Air Technical Service Command, air forces and commands, and to organize special schools, conferences, and tours for visiting personnel from military and civilian agencies, both native and foreign.



AERO MEDICAL LABORATORY

The Aero Medical Department AAF School

The AAF Center (see Section 2-3) has two functional agencies. One agency, the *AAF School,* is organized as a teaching unit. The other, the *Demonstration Air Force,* made up of representative units of all types of combat and service organizations, is set up at satellite airdomes operating under conditions simulating those of an active theater of operations. By close integration of the two, the lessons learned from actual combat can be translated into definite policies.

The school itself consists of the necessary functional departments: combat operations, intelligence, logistics, communications, staff and special training, inspection, aero medical, and antiaircraft artillery. Each is responsible for the presentation of its phase of instruction to all groups of students. Senior AAF officers with high command responsibilities receive an intensive short survey of the latest developments and principles of air warfare. Ground and naval officers receive an indoctrination in the operations of the AAF. AAF staff officers, intelligence officers, antiaircraft officers, task force officers, and inspection officers follow specially prepared curricula which better prepare and integrate our whole fighting force into one unified team.

To all these groups, the Aero Medical Department presents the medical responsibilities which these students will have as staff officers. These include proper sanitation, malaria discipline, control of venereal disease and the proper training for and protection of their men in the medical problems associated with ascent to high altitude. In addition, they must be made cognizant of the echelons of medical service available to them, the proper means of utilization of evacuation by both ground and air, and the value of recommendations of their unit surgeon.

Medical personnel also receive training at the AAF School. The courses given familiarize medical officers with the tactical problems in a combat theater and prepare them to assume their staff responsibilities whether with a squadron, group, command, wing, or an air force. There are two courses of instruction. One, the *Tactical Surgeon's Course,* lasting 20 days, is designed for squadron and group surgeons. The other, the *Senior Medical Staff Officers Course,* of 6 days duration, is designed for wing and higher level staff officers of the grade of lieutenant colonel and above.

In both these courses, the Medical Department officer has a graphic presentation of AAF tactical operations presented by AAF personnel, most of whom have had recent combat experiences. The Tactical Surgeon's Course includes one week spent at an operational airdrome where, under simulated combat conditions, a group dispensary operates, high altitude bombardment missions are flown, aerial evacuation of casualties is performed, sanitary and mosquito surveys are made of the airdrome site and every contingency of field service is covered.

In addition to these courses for medical officers the Aero Medical Department trains *personal equipment officers* for the AAF. This course originally instituted at the AAF School of Aviation Medicine at Randolph Field was later transferred to the AAF School at Orlando.

Medical Service Training School

Establishment and Control. The AAF Medical Service Training School was established in November, 1943, at Robins Field, Warner-Robins, Georgia.

The school was placed under the control of the Commanding General, AAF, and the Commanding General, Air Service Command, was directed to provide trained personnel to staff the school without any increase in the overall allotment to the Air Service Command. The commandant was authorized to communicate directly with the Commanding General, AAF, for administrative purposes.

In September, 1944, the school was organized as the 25th AAF Base Unit and assigned to Headquarters, AAF, though still stationed at Robins Field.

Mission. The overall mission of the school is to instruct and train Medical Department personnel for duty with field units of the AAF. This includes the preparation of hospital trained technicians for duty with overseas field units; the accomplishment of all other requirements for overseas units in accordance with POR and other pertinent War Department and AAF directives; the activation, training, and preparation of medical dispensaries, aviation, for overseas duty.

Organization and Operation. Exact Manning Table No. 25, dated 15 Sept 1944, authorizes 14 officers, including 4 Medical Corps officers, 1 Dental Corps officer, and 9 Medical Administrative Corps officers. The 100 enlisted specialists are subdivided into 22 military occupational specialties, 9 of which are peculiar to the Medical Department, AAF. These men are organized into the departments and sections indicated in the accompanying organizational and responsibility diagram.

Training Programs. These are as follows:

1. Six Weeks Field Training Program. This is the primary course of instruction for enlisted personnel who are to serve either as casual replacements or as fillers for newly activated medical dispensaries, aviation. It consists of 360 training hours, 88 of which are devoted to adapting the hospital trained technician to his specific technical duties under field conditions. To accomplish this, 10 different field MOS schools are operated in which the various technicians receive specialized field technical training. These field schools are: medical administrative, medical supply, dental assistant, drivers, cooks, medical corpsman, medical and surgical technician, pharmacy technician, sanitary technician, and radiology technician. Basic laboratory training is included in the pharmacy technician curriculum, and flight surgeon's assistants are given special training to accustom them to working with their authorized equipment under field conditions. The remainder of the training program consists of basic, technical, and tactical training, designed to comply with War Department and AAF Training Directives. All personnel participate in this latter training. Two bivouac training periods give all personnel at least 10 days and nights of experience in carrying out their future missions under simulated combat conditions. This includes living and working together in a provisional medical section or unit.

2. Six Weeks Advanced Field Training Program. This course is a progressive continuation of technical and tactical training designed to increase the proficiency of the various field trained technicians for duty with field units. It consists primarily of field medical and surgical care, malarial control activity, chemical warfare training, individual and unit defensive measures, and progressive physical conditioning.

3. Unit Training Programs. Individual medical dispensaries, aviation, are given special section and unit training, including simulated combined training missions designed to develop greater proficiency for the unit as a whole.

REFERENCES

AGO Ltr, Establishment of an Army Air Forces Medical Service Training School, 30 Oct 1943.

AAF Reg. 20-28, AAF medical service training school, 17 Oct 1944.

AAF Ltr. 20-40, Organization of the 25th AAF Base Unit (AAF Medical Service Training School), 18 Aug 1944.

AAF Ltr., AAF Medical Service Training School, 19 Nov 1943. Exact Manning Table No. 25.

AAF Ltr., Policy concerning the AAF Medical Service Training School, 21 Jan 1944.

AAF Training Standard 110-1-1, Training for units and individuals of the Medical Department of the Army Air Forces, 20 Apr 1944.

The 4520th AAF Base Unit (Medical School)

In November, 1943, the Air Service Command expressed the desire to create a medical training detachment at Robins Field for the purpose of training medical sections of the air depot groups, service groups, and medical supply platoons, aviation. It was desired that this detachment work in conjunction with and use the facilities of the AAF Medical Service Training School. Accordingly, several directives appeared for the purpose of establishing this training structure and its policy. At first the unit was called the Medical Training Detachment No. 1, was stationed at Robins Field, Georgia, and was attached to the AAF Medical Service Training School for quarters, rations, administration and duty. In March, 1944, the personnel of this new unit was established as the 4520th AAF Base Unit (Medical School). A few months later the policy with regard to administration of the unit was changed so that it operated administratively independent of the AAF Medical Service Training School.

Mission. The mission of the 4520th AAF Base Unit (Medical School) is to accomplish field training for medical detachment personnel of the Air Technical Service Command. This includes training of casual replacements and fillers for medical sections of air depot groups, service groups, and medical supply platoons, aviation. The supervision of unit training for medical supply platoons, aviation, is included in the mission of this organization.

Organization, Operation and Training Programs. The 4520th AAF Base Unit (Medical School) consists of 10 officers and 50 enlisted men with MOS's and SSN's, grades and ratings in accordance with the manning guides so outlined in Special Order No. 27, Headquarters, Robins Field, 1 Feb 1944.

Personnel of the Air Technical Service Command receive the same training as that given by the AAF Medical Service Training School to any other personnel. Personnel from the Air Technical Service Command and from other AAF commands make up the classes, but the former receive additional training required by directives issued by the Air Technical Service Command.

MISCELLANEOUS INSTALLATIONS

Medical Safety Division, Office of Flying Safety

The Office of Flying Safety is a part of the Headquarters, AAF, and is directed to establish, supervise, and regulate a system of aircraft investigation, reporting analysis and prevention. From data supplied by accident reports, recommendations for corrective action are made. The Medical Safety Division, Office of Flying Safety, working under the medical policies of the Air Surgeon and in coordination with the Office of the Air Surgeon is concerned with the medical aspects of accident investigation and prevention. From data furnished by Form 205, information is obtained on three main subjects: survival procedures, the prevention of injuries in aircraft accidents, and from a medical standpoint, the prevention of accidents themselves. Recommendations concerning training procedures, protective equipment, and other safety measures are made by this division.

REFERENCES

AAF Reg. 20-26, Organization, Office of Flying Safety, 1 July 1944.

AAF Board

The AAF Board consists of a president, appointed by the Commanding General, AAF; the Assistant Chief of Air Staff, Operations, Commitments and Requirements; the commanding general of the AAF Center; the commanding general, AAF Proving Ground Command; and a recorder, without vote.

The president maintains his office and staff at the AAF Center, Orlando, Florida. The staff is functionally organized into aircraft, tactics, armament, equipment, communications and evaluation divisions.

In general, projects concerning materiel which do not specifically pertain to the other divisions are assigned to the equipment division. These include projects on physiological and personal equipment.

Projects usually pertain to new tactical ideas or new items of materiel and are normally activated on receipt of a directive or request for review from the Commanding General, AAF, or from the AAF Air Technical Service Command. Other agencies may request the activation of an AAF Board Project by letter addressed to the Commanding General, AAF; Attention: AAF Board Control Office, Washington 25, D. C.

After activating a project, the president of the board calls upon an agency designated by him to conduct any testing required. Normally, the facilities of the AAF Proving Ground Command or the AAF Center are utilized; however, he may call upon any agency within the continental limits of the U. S. for personnel or facilities which may be necessary for the completion of a project.

The reports of these testing agencies are evaluated by the board, and in the light of the experience of its personnel and other information obtained, the recommended disposiiton of the materiel or doctrine is determined.

A report is then prepared and forwarded to the Commanding General, AAF. In the case of new equipment not favorably considered, the recommendation is that it be dropped from further consideration; when favorably considered, standardization, basis of issue, and other appropriate recommendations are submitted.

The AAF Board Control Office distributes the report to appropriate agencies at Headquarters, AAF, where final action thereon is taken.

With regard to materiel, the board is also charged with investigating the military requirement for items of equipment suggested for development and with stating the characteristics desired thereof.

One medical officer is at present assigned to duty on the staff of the AAF Board in the Equipment Division as a project officer. He also coordinates AAF Board matters referred to him for opinion of medical authority.

REFERENCES

AAF Reg. 20-20, Organization AAF Board, 26 Apr 1944.

Arctic, Desert, and Tropic Information Branch Medical Section

The Medical Section of the Arctic, Desert and Tropic Information Branch was inaugurated in March 1943, some months after the establishment of other technical organizations in the AAF Center (see Section 2-3). Personnel were assigned by the Research Division of the Air Surgeon's Office. Activities are reported to, and published information is cleared through, this division.

The function of the Medical Section, which is also the function of the entire organization, may be stated as follows:

Collect, record, coordinate, compile by investiga-

tion and research of all available sources, and prepare for publication and dissemination in appropriate form information bearing upon AAF activities in arctic, desert, and tropic regions. Furnish available information requested by AAF organizations.

Since much of the medical information on nontemperate regions prepared by other agencies is not distributed to squadron surgeons, one of the duties of the Medical Section has been to prepare and distribute to the squadron surgeons information on tropical diseases, studies of geographical areas where the AAF might be operating, and data on arctic conditions. Three series of pamphlets for medical officers have been published. A fourth series published as ADTIC Bulletins 7, 8, and 9 have been prepared on care of personnel in the arctic, desert, and tropics, but these were written as training material for nonmedical readers.

REFERENCES

AAF Reg. 20-17, Organization of Arctic, Desert and Tropic Information Center, 22 Apr 1944.

Physiological Section, AAF Proving Ground Command

Physiological work at the AAF Proving Ground Command is conducted by a Physiological Projects Section in the Proof Division and a Physiological Test Section. The project officers are responsible for the preparation and presentation of programs and reports and the test officers are responsible for carrying out the tests. In many instances a test officer from the Flight, Medical or Ordnance Sections in the command may also be designated to bring his special knowledge to bear upon the test.

The function of the AFPGC is testing the suitability of AAF materiel for service use. When materiel is considered ready for procurement, it is submitted to the AFPGC for critical testing under the conditions significant for its employment in service.

Requests for testing and study at the Proving Ground are submitted by the developing agency to the AAF Board for transmission to the AFPGC, and programs for testing and reports are returned from the Proving Ground to the AAF Board in order that the conclusions and recommendations may be directed through the channels for obtaining proper procurement and distribution.

The Proving Ground is located on a 600-square mile reservation along the Gulf of Mexico with about 60 land and water ranges and 10 auxiliary fields. About a dozen separate detachments of the command are stationed at sites such as Aberdeen, where ordnance testing related to the work of the AFPGC is in progress, and at Ladd Field, Alaska, where the special climatic and terrain conditions make an important natural testing site.

Physiological service testing was established in July 1943. From then until 30 December 1944 about 80 tests had been performed on oxygen equipment, personal equipment and medical items for operational use. The requests for testing originate principally in the Aero Medical and Personal Equipment Laboratories of the Air Technical Service Command and in the offices of the Air Surgeon and Air Quartermaster. A number of subjects, however, have been submitted for testing after initial development in the AFPGC, for the command operates on a broad directive for developing and improving the equipment of the AAF.

The personnel, airplanes, shops and entire equipment of the Proving Ground are regularly subjecting new airplanes, equipment, and weapons to severe practical tests of their service value. For physiological study there is consequently a large background of new material and operations in which experienced personnel are at work.

The Physiological Laboratory is temporarily housed in one hangar. Permanent housing is in prospect in the hangar for climatic test work, where a controlled climate room and a refrigerated low pressure chamber are now being installed.

Central Medical Establishment

Organization

The Central Medical Establishment is an organic element of the AAF designed to provide special aeromedical services in theaters of operations.

Normally in each air force there is a Central Medical Establishment attached to the headquarters and under the supervision of the air force surgeon. The unit is commanded by the senior flight surgeon assigned thereto and present for duty.

The Central Medical Establishment, as presently organized is a flexible organization which may be varied according to circumstances prevailing within the air force. It is usually composed of approximately 10 officers and 25 enlisted men and is divided into functional units which may also vary in different air forces. The following is a typical example:

Headquarters—1 officer, 15 enlisted men.

Central Medical Board—3 officers, 1 enlisted man.

Aircrew Indoctrination—3 officers, 5 enlisted men.

Aviation Medicine—3 officers, 4 enlisted men

In addition, an altitude training unit (T/D 1-1897) is assigned to operate in conjunction with, or as an integral part of, the Central Medical Establishment. The functional units may be divided in various ways, to include units for psychiatric study and research and development. Further variations may be obtained by assigning certain functions to other officers as additional duties.

Personnel

Officers. The flight surgeon in charge of the headquarters section is especially qualified in the administrative aspects of aviation medicine.

The flight surgeons assigned to the Central Medical Board are each qualified in one of the following medical specialties: internal medicine, eye-ear-nose and throat, and psychiatry.

The flight surgeons assigned to the Aircrew Indoctrination Unit are specialists in the various aspects of the physiology of high altitude flight, the operation of decompression chambers, and the care and use of personal flying equipment.

The officers of the Aviation Medicine Section, one of whom is an aviation physiologist, and the others flight surgeons, are especially qualified to perform research on the problems incident to the care of flying personnel.

Enlisted. The enlisted men are qualified to assist the flight surgeons of the particular section to which they are assigned.

Functions

The Headquarters Section coordinates the activities of the other sections of the Central Medical Establishment, and provides administrative supervision to include routine correspondence, organizational administration, and the preparation and forwarding of reports, research data, etc.

The Central Medical Board, presided over by its senior medical officer, serves as the reviewing authority within the air force on all questions pertaining to the medical status of flying personnel, and when directed by proper authority, performs examinations to determine an individual's physical qualifications for flying duty. It also furnishes consultation service to flight surgeons on all matters pertaining to the physical examination for flying, WD AGO Form 64, when greater than average training and experience is required to evaluate the status of individuals with a condition resulting from disease or injury, or emotional maladjustment, neuroses, and the early stages of insanity. The board may also make recommendations in conjunction with the Aviation Medical Section in regard to the care and treatment of flying personnel (see Section 3).

The Aircrew Indoctrination Unit has the following functions, which are performed with the assistance of the altitude training unit:

Presenting refresher courses to combat crews and aircrews and medical officers in the physiology and special problems of high altitude flight.

Indoctrinating all flying personnel, flight surgeons, and unit personal equipment officers in the use and maintenance of protective flying equipment (oxygen masks, electrically heated clothing, etc.), emphasizing the special problems met within that theater.

Studying the complaints of airmen with reference to inability to tolerate high altitude, in order to differentiate between neuroses, malingering, hysteria, and organic defects.

Testing individuals suffering from chronic mild sinusitis, eustachian orifice infection, and other conditions, to determine their ability to tolerate changes of altitude.

Testing new, modified, or unsatisfactory flying equipment such as oxygen masks and electrically heated flying suits, and making appropriate recommendations.

The Aviation Medicine Section is concerned with all problems pertaining to the care of the flyer. The work carried on by this section includes the following:

Gathering knowledge gained from experience by all flight surgeons in the air force.

Keeping currently informed of all work done on aero-medical problems in the zone of interior and other theaters.

Performing aero-medical research for on-the-spot solution of problems peculiar to the theater.

Compiling data gained from all sources from research and experience for distribution to all unit flight surgeons.

Formulating corrective measures wherever possible for anything which adversely affects the efficiency, health, or safety of flying personnel.

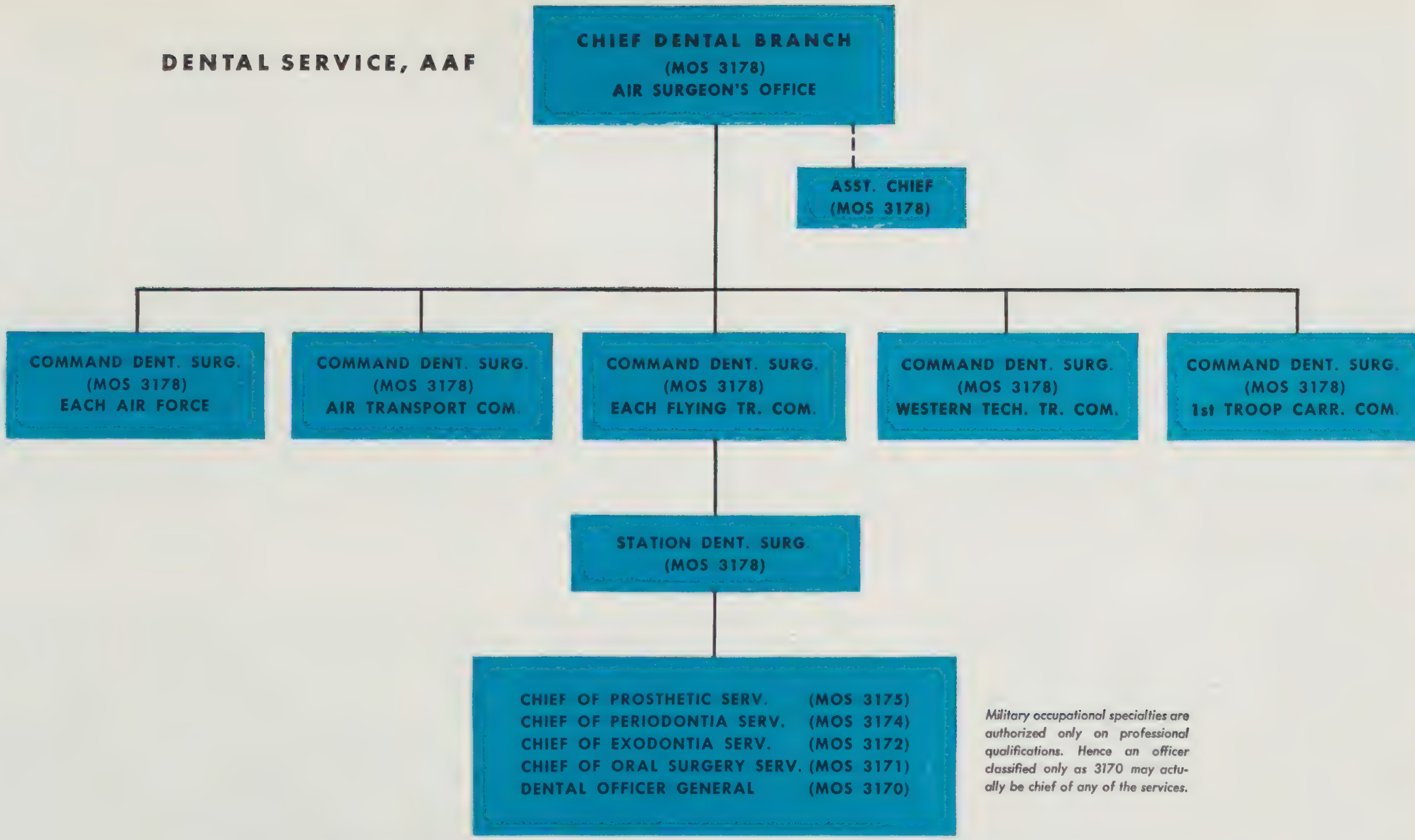
Analyzing factors relating to wounds from aerial combat, aircraft accidents, and illnesses resulting in attrition of flying personnel.

Studying operational fatigue in all of its aspects.

Coordinating with and advising the proper command on all medical aspects of emergency rescue activities.

All personnel of the Central Medical Establishment are available to the air force surgeon to assist in the presentation of orientation courses in all health, sanitary, disease, and aero-medical problems peculiar to the theater.

DENTAL SERVICE, AAF



Military occupational specialties are authorized only on professional qualifications. Hence an officer classified only as 3170 may actually be chief of any of the services.

EACH MAJOR COMMAND HAS A COMMAND DENTAL SURGEON EXCEPT THE AIR TECHNICAL SERVICE COMMAND, and THE EASTERN TECHNICAL TRAINING COMMAND

DENTAL CLINICS AND FACILITIES
D.C. 1—25 CHAIRS 24 UNITS
D.C. 2—15 CHAIRS 14 UNITS
D.C. 3— 8 CHAIRS 7 UNITS
D.C. 4— 3 CHAIRS 3 UNITS
D.C. 5— 1 CHAIR 1 UNIT

Dental clinics are authorized according to military strength, therefore any combination of the above may be found at a station.

Z-I-DENTAL LABORATORY
AUTHORIZED FOR STATIONS
HAVING MILITARY STRENGTH
of 10,000 OR MORE.
1 OFFICER (MAJ.) 10 EM PER SHIFT

THE FLIGHT SURGEON'S OFFICE

General

The operation of a flight surgeon's office varies with the functions of the AAF station or unit of which it is a part. The information given here, although more generally appropriate to a fixed installation, is essentially applicable to a flight surgeon's office in any type or organization.

Location

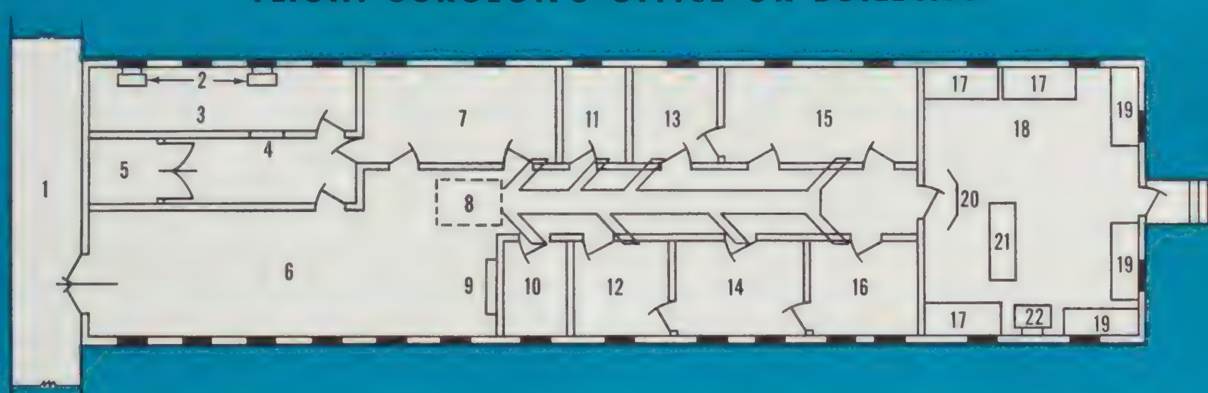
The location of the flight surgeon's office varies with the type of unit. There are advantages of its location as a part of a hospital when the organization is at a fixed installation. There are other advantages of its location near the flying line. Generally, the closer it is to the operations office, the better.

Design

The office must be so designed that it permits privacy for consultations. Its construction or arrangement, insofar as the conduction of the physical examination is concerned, must be such that the sequence of conducting the examination is in keeping with recommended procedures of the Army Regulations concerning the physical examination for flying.

The atmosphere must be such that the flyer is put at ease. When possible, there should be comfortable furnishings and equipment to make waiting periods less tedious. Such factors as heating, lighting and ventilation demand consideration. Dark lanes or dark rooms must be of proper length and lighting.

SUGGESTED PLAN
FLIGHT SURGEON'S OFFICE OR BUILDING



1. Passageway to other bldgs. of Hospital Area
2. Window type self contained mechanical cooling units
3. Eye Room
4. 12″ x 24″ Louver with adjustable shutter
5. Sound proof Audiometer Room
6. Waiting Room
7. E. N. T. Room
8. Evaporative cooler on roof
9. Shelf
10. Receptionist
11. Latrine
12. Special Examining Room
13. Sgt. Major
14. Flight Surgeon
15. Records Room (Clerks and Typists)
16. Asst. Flight Surgeon
17. Clothes Locker
18. Examining Room
19. Examining Table
20. Screen
21. Table
22. 3 Ton self contained air conditioning unit

Personnel

The number of personnel in the flight surgeon's office varies with the size of the installation. A basic nucleus is necessary in each installation approximately as follows:

Flight Surgeon (see Section 1-1).

Senior Non-Commissioned Officer. This key man should:

1. Be a graduate flight surgeon's enlisted assistant (see Section 1-3).
2. Be a leader capable of supervising the work of the entire flight surgeon's office under the direction of the flight surgeon.
3. Be capable of making minor mechanical adjustments and repairs to all equipment used in making the physical examination for flying.
4. Act as the flight surgeon's assistant in conducting physical examinations by noting findings on appropriate work sheets and by making miscellaneous observations concerning the least technical portions of the examination.
5. Be capable of scheduling examinations and instruction classes.
6. Supervise the notations in the daily sick book pertaining to medical entries.
7. Supervise all transcriptions of physical examination work sheets into final records.
8. Be qualified to initiate and maintain all records which are normally located in the flight surgeon's office.

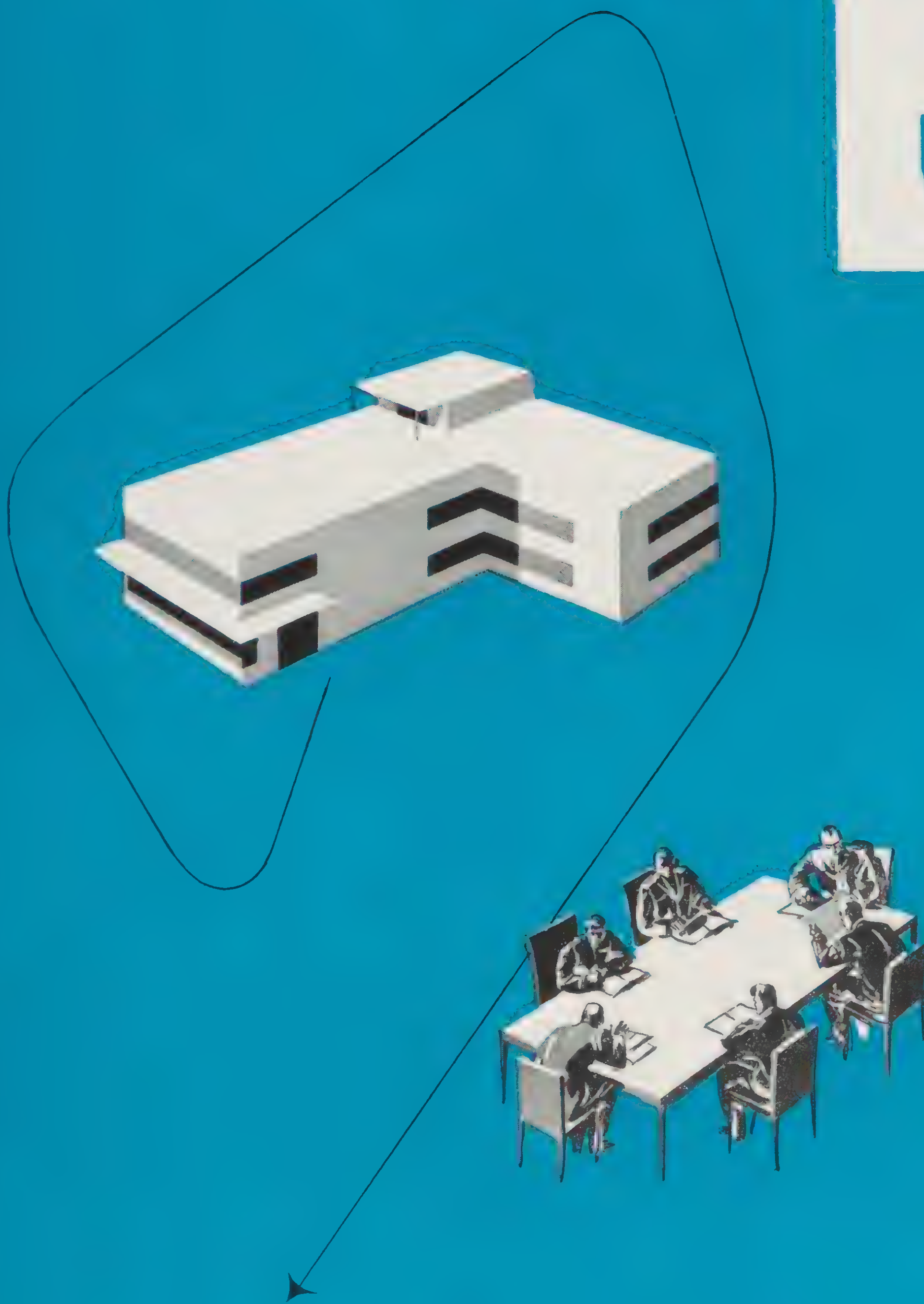
Enlisted Assistant in Charge of the Eye Examining Room. This position requires an individual who has training as a flight surgeon's assistant and has shown himself to be particularly adapted to this type of work. Frequently it is possible to obtain technically trained enlisted men who have had previous experience in this work. This assistant must be familiar with all notations pertaining to the eye examination in military aviation.

Record Clerk. This essential job may be filled by a clerk typist who has thorough knowledge of military correspondence, organizations, and of the standard methods of filing.

Stenographer. In large installations the volume of work will require a capable medical stenographer.

Records (see Section 5-2)

SECTION 3



HOSPITALS AND BOARDS

SECTION 3

HOSPITALS AND BOARDS

1. AAF Hospitals.
2. Hospitalization in the Theater of Operations.
3. Central Medical Examining Board.
4. Flying Evaluation Board.
5. Medical Disposition Board.
6. Army Retiring Board.
7. Flight Surgeons Reclassification Board.
8. Aircraft Accident Investigating Board.

AAF HOSPITALS

The Station Hospital

The present trend in the station hospital is to provide care only for minor illnesses and injuries in personnel at the station. For this reason the professional staff consists of an officer trained in general medicine (C 3139), one in general surgery (C 3150), and one in otorhinolaryngology (C 3106). It is planned to transfer all patients requiring any type of specialized diagnostic procedures or prolonged therapy to the nearest regional hospital.

To insure the most economical use of supplies and personnel, based upon the actual strength that the hospital serves, a sufficient number of beds is authorized to hospitalize 3.5% of the local post strength. To insure the continued economical operation of these hospitals the Commanding General, AAF, publishes revised lists of bed authorizations at semi-annual intervals, or more often if conditions demand. To effect changes in authorization commensurate with the needs of the hospital, studies are made of average bed occupancy over the latest six months period. To this average figure another 20% is added in keeping with the policy of the Air Surgeon of authorizing beds at such a level that 80% of the beds will be actually occupied. Ten percent more is added to provide for seasonal variations to be expected in the hospital census.

Records of fixed hospital beds are maintained showing the capacity of each hospital on the basis of 100 square feet per bed (normal bed capacity), and also on the basis of 72 square feet per bed (total bed capacity). There are approximately 200 AAF station hospitals, ranging in capacity from 50 to 800 beds, with a total of approximately 40,000 beds.

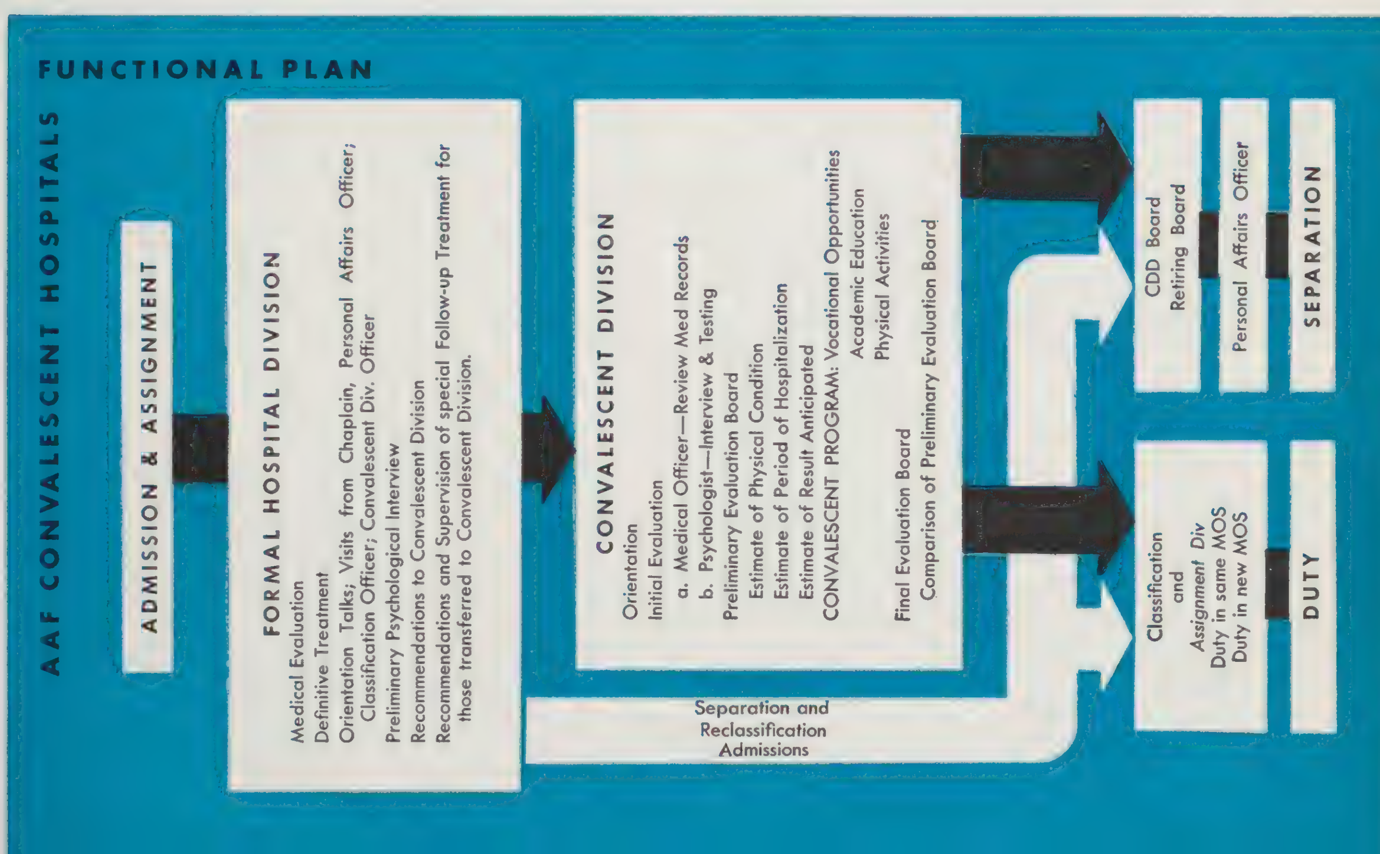
The Regional Hospital

The AAF has 30 regional hospitals in operation. Twenty-five thousand beds provide for 3.5% of the local post strength where the hospitals are located as station hospitals, and also for 0.5% of the strength of the area they serve in their capacity as regional hospitals. These installations supply definitive medical and surgical care for all patients except those requiring specialized treatment at general hospitals.

AAF regional hospitals vary in size from 250 to 1500 beds, and possess well balanced and capable professional staffs.

The Convalescent Hospitals

The convalescent hospitals are under the supervision of the Personnel Distribution Command (see Section 2-3). Each hospital is divided into a formal hospital division and a convalescent division. The functions of each are demonstrated in the accompanying chart (see Section 10-5).



AAF REGIONAL HOSPITALS

Westover Field, Mass.
Mitchel Field, N. Y.
Langley Field, Va.
AAF Regional Station Hospital No. 1, Fla.
Drew Field, Fla.
Greensboro, N. C.
Keesler Field, Miss.
Maxwell Field, Ala.
Orlando Army Air Base, Fla.
Patterson Field, Ohio
Chanute Field, Ill.
Scott Field, Ill.
Truax Field, Wis.
Buckley Field, Colo.
Lincoln Army Air Field, Neb.
Sioux Falls Army Air Field, S. D.
Amarillo Army Air Field, Tex.
Barksdale Field, La.
San Antonio Aviation Cadet Center, Tex.
Sheppard Field, Tex.
Davis-Monthan Field, Ariz.
Hammer Field, Calif.
Kearns Field, Utah
Smoky Hill AAF, Salina, Kans.
Pyote Army Air Field, Tex.
Hamilton Field, Calif.
Eglin Field, Fla.
Hunter Field, Ga.
Robins Field, Ga.
Waltham Regional Hospital, Mass.
Fort Monmouth, N. J.
Fort Jay, N. Y.
Fort Meade, Md.
Camp Lee, Va.
Fort Benning, Ga.
Camp Blanding, Fla.
Fort Bragg, N. C.
Fort Jackson, S. C.
Fort McClellan, Ala.
Camp Shelby, Miss.
Camp Stewart, Ga.
Fort Knox, Ky.
Fort Riley, Kans.
Camp Crowder, Mo.
Fort Leonard Wood, Mo.
Fort F. E. Warren, Wyo.
Camp Jos. T. Robinson, Ark.
Camp Polk, La.
Camp Maxey, Tex.
Camp Swift, Tex.
Camp Barkeley, Tex.
Fort Ord, Calif.
Camp Haan, Calif.
Oakland Area Station Hospital, Calif.
Pasadena Area Station Hospital, Calif.

AAF CONVALESCENT HOSPITALS (ZI)

Bowman Field, Ky.
Fort Logan, Colo.
St. Petersburg, Fla.
Pawling, N. Y.
Camp Davis, N. C.
Richmond, Va.
Ft. George Wright, Wash.
Fort Thomas, Ky.
Plattsburg, N. Y.
Santa Ana Army Air Base, Calif.
Miami Beach, Fla.
Welch, Fla.
Mitchell, Calif.
Old Farms (Special), Mass.
Ft. Story, Va.
Camp Butner, N. C.
Camp Carson, Colorado
Lovell, Mass.
England, N. J.
Walter Reed, D. C.
Brooke, Tex.
Wakeman, Ind.
Percy Jones, Mich.
Ft. Lewis, Wash.

NAMED GENERAL HOSPITALS

Army Medical Center (Walter Reed)
  Washington, D. C.
Ashford General Hospital
  White Sulphur Springs, W. Va.
Battey General Hospital
  Rome, Geoagia
Billings General Hospital
  Ft. Benjamin Harrison, Ind.
Brooke General Hospital
  Ft. Sam Houston, Tex.
Crile General Hospital
  Cleveland, Ohio
Deshon General Hospital
  Butler, Pa.
England General Hospital
  Atlantic City, N. J.
Fletcher General Hospital
  Cambridge, Ohio
Glennan General Hospital
  Okmulgee, Okla.
Harmon General Hospital
  Longview, Tex.
Kennedy General Hospital
  Memphis, Tenn.
Letterman General Hospital
  San Francisco, Calif.
Mayo General Hospital
  Galesburg, Ill.
McGuire General Hospital
  Richmond, Va.
Northington General Hospital
  Tuscaloosa, Ala.
Rhoads General Hospital
  Utica, N. Y.
Thayer General Hospital
  Nashville, Tenn.
Valley Forge General Hospital
  Phoenixville, Pa.
Woodrow Wilson General Hospital
  Staunton, Va.
Army & Navy General Hospital
  Hot Springs, Ark.
Newton D. Baker General Hospital
  Martinsburg, W. Va.
Baxter General Hospital
  Spokane, Wash.
Birmingham General Hospital
  Van Nuys, Calif.
Bruns General Hospital
  Santa Fe, New Mexico
Cushing General Hospital
  Framingham, Mass.
DeWitt General Hospital
  Auburn, Calif.
Finney General Hospital
  Thomasville, Ga.
Foster General Hospital
  Jackson, Miss.
Halloran General Hospital
  Willowbrook, S. I., N. Y.
Hoff General Hospital
  Santa Barbara, Calif.
LaGarde General Hospital
  New Orleans, La.
Lovell General Hospital
  Ayer, Mass.
McCaw General Hospital
  Walla Walla, Wash.
Moore General Hospital
  Swannanoa, N. C.
Oliver General Hospital
  Augusta, Ga.
Schick General Hospital
  Clinton, Iowa
Tilton General Hospital
  Fort Dix, N. J.
Vaughan General Hospital
  Hines, Ill.
Wakeman General Hospital
  Columbus, Ind.
Ashburn General Hospital
  McKinney, Tex.
Barnes General Hospital
  Vancouver, Wash.
William Beaumont General Hospital
  El Paso, Tex.
Borden General Hospital
  Chickasha, Okla.
Bushnell General Hospital
  Brigham City, Utah
Darnell General Hospital
  Danville, Ky.
Dibble General Hospital
  Palo Alto, Calif.
Fitzsimons General Hospital
  Denver, Colo.
Gardner General Hospital
  Chicago, Ill.
Hammond General Hospital
  Modesto, Calif.
Percy Jones General Hospital
  Battle Creek, Mich.
Lawson General Hospital
  Atlanta, Ga.
Mason General Hospital
  Brentwood, L. I., N. Y.
McCloskey General Hospital
  Temple, Tex.
Nichols General Hospital
  Louisville, Ky.
O'Reilly General Hospital
  Springfield, Mo.
Stark General Hospital
  Charleston, S. C.
Torney General Hospital
  Palm Springs, Calif.
Winter General Hospital
  Topeka, Kans.
Ft. Lewis General Hospital
  Ft. Lewis, Wash.

AAF Debarkation Hospitals

Station Hospital, Bolling Field, D.C.
Regional Hospital, Coral Gables, Florida
Station Hospital, Great Falls AAF, Great Falls, Montana
Regional Hospital, Hamilton Field, San Rafael, California
Station Hospital, Mather Field, Sacramento, California
Regional Hospital, Mitchel Field, Long Island, New York
Station Hospital, Portland Army Air Base, Portland, Oregon
Station Hospital, Presque Isle Army Air Field, Presque Isle, Me.

The debarkation hospital serves as a hospital for the reception of patients from overseas theaters. The medical regulating officer in the zone of the interior is informed daily of the number of patients arriving and makes arrangements for their distribution to appropriate hospitals in the zone of the interior.

REFERENCES

WD Cir 228, Hospital, zone of interior, 7 June 44.

TM 8-260, Fixed hospitals of the Medical Department (general and station hospitals), 16 Jul 1941.

WD Cir 140, Hospitalization and evacuation of personnel in the zone of interior, 11 Apr 1944.

AR 40-590, Administration of hospitals, general provisions, 29 Aug 1944.

AAF Installations directory, continental United States, 1 Jan 1945.

WD Cir 347, General hospital, 25 Aug 1944.

AAF Ltr 25-10 Air debarkation hospitals, 9 Dec 1944.

AAF Reg 25-17, AAF hospitalization and evacuation in continental United States, 6 June 1944.

HOSPITALIZATION IN THE THEATER OF OPERATIONS

Organic hospitalization of all army personnel in the theater is furnished normally by installations of the AGF and ASF.

Mobile Hospitals

The wounded soldier is moved from his unit to the infantry battalion aid station, to the collecting station, to the clearing station (see Section 4-1). In general it may be stated that all transportable casualties requiring evacuation farther back are moved from the clearing station by motor ambulance to an evacuation-type hospital within army jurisdiction.

Evacuation Hospital, semimobile. This hospital is located roughly 10 to 50 miles from the front areas of contact behind divisional clearing stations and is of 400 bed capacity. Assigned on the basis of one per division, it has motor transportation and moves by shuttling. It may be housed either in existing buildings or within its own tentage. The equipment and personnel are adequate for giving proper emergency surgical treatment and post-operative care. The personnel include not only general surgeons but those qualified in orthopedics, maxillo-facial surgery, and neurosurgery. Care given is intended to be primarily of an emergency nature. Appropriate chemotherapy may be instituted, debridement of wounds accomplished, and fractures adequately immobilized with plaster. A patient is held only as long as his condition actually warrants. As soon as possible each evacuee is forwarded by rail, motor, or air to a convalescent hospital in the army area or fixed hospital in the communications zone.

Evacuation Hospital. This hospital has a capacity of 750 beds and is less mobile than the semimobile installation. It is assigned on the basis of 1 per 3 divisions and usually moves by rail but can be moved by army motor convoy. It is set up in the Army Service Area in as close support as the tactical situation permits.

Portable Surgical Hospital. This is a mobile surgical unit of 25 beds capacity designed primarily for jungle operations. Weighing about 1000 pounds it can be rapidly established, closed, and moved by handcarry in waterproof containers. It is intended for use well forward in the vicinity of clearing stations and is assigned at the rate of 3 to 9 per division.

Convalescent Hospital. This installation, assigned 1 per 9 divisions, is located in an area of army jurisdiction. It has a normal bed capacity of 3000 beds but may be expanded for short periods to as many as 5000 beds. Located preferably near the Army Replacement Pool, it is intended to care for patients who do not need further definitive treatment in an evacuation-type hospital and whose duration of incapacity and prognosis do not require transfer to a fixed hospital outside the combat zone. These include venereal cases and convalescents who are expected to return to full field duty within a reasonable time.

Professional Service Unit. This theater unit is assigned at the rate of 1 per 75,000 troops in the theater and is made up of surgical, orthopedic, shock, maxillo-facial, neurological, thoracic surgical, and gas teams. These may be used to reinforce any medical installation or unit requiring additional surgical facilities and personnel.

Fixed Hospitals

In the communications zone, the rearmost portion of a theater of operations, three types of hospitals are set up: general, station, and field hospitals.

General Hospital. For a theater, these are priority units and established whenever armed forces proceed to a theater. Intended to provide definitive treatment, they are opened as soon as a secure overseas base has been established. The normal capacity of 1000 beds may be expanded temporarily to about 2000 beds for short periods. The number of hospitals of this type to be employed in any area will depend largely on the proximity of the theater to the zone of interior. They receive cases by hospital train, motor, or air ambulance directly from evacuation hospitals and from other fixed hospitals making retrograde secondary evacuations. Only those cases requiring special treatment, prolonged hospitalization, or those permanently incapacitated, would be transferred to the zone of interior. Where possible, two or more general hospitals with a convalescent camp having a capacity of 1000 beds are grouped together as a "Hospital Center."

Station Hospital. Certain hospital facilities must be provided for the care of incidental sick and injured in the communications zone. At each military station or organized center there is provided a station hospital. These normally receive patients only from the station or center to which they are attached. They are variable in size; Tables of Organization are available for units from 25 to 900 beds capacity.

Field Hospital. This installation is a theater unit, used to cover air fields and island garrisons, or small task forces where other fixed hospital bed facilities are not present and their construction not feasible.

The equipment is packed in small units and can be transported on trucks, by air, or any other means of transportation. It may be set up either as a single unit of 400 beds or as three separate 100 bed units, each acting independently and manned by a single platoon.

Evacuation Policy

This is a command decision and is made by the War Department upon the recommendation or with the concurrence of the theater commander concerned. It indicates the length in days of the maximum period of noneffectiveness for patients held in the theater for treatment. Patients who, in the opinion of responsible medical officers, cannot be returned to a duty status within the period prescribed are returned to the zone of interior by the first available and suitable transportation, provided the travel required will not aggravate their disabilities. A 120-day evacuation policy has been generally accepted as a reasonable period in advance planning for fixed hospitalization in an active theater (see Section 4).

Casualty Estimates

Losses of personnel in ground echelons assigned to an AAF unit are occasioned primarily by disease and non-battle injuries. Rates of losses due to these causes vary widely between the various theaters. The cumulative rate of loss will vary with the evacuation policy used in the theater. Air crew attrition in a similar manner varies significantly because of differences in effectiveness of enemy resistance, climatic and geographic conditions, and operating conditions in general. The policy of enforced rest periods following completion of several combat missions further complicates computations of attrition rates. For details of methods employed in estimating casualty and replacement rates, reference should be made to FM 101-10.

REFERENCES

T/O and E 5-500, Medical Department, service organization, 23 Apr 1944.

T/O and E 8-510, C4, Field hospital, 20 June 1944.

T/O and E 8-550, General hospital, 3 Jul 1944.

T/O and E 8-560, Station hospital, 28 Oct 1944.

T/O and E 5-572S, Portable surgical hospital, 2 Sept 1943.

T/O and E 8-580, Evacuation hospital, 23 Apr 1943.

T/O and E 8-581, Evacuation hospital, semimobile, 26 Jul 1943.

T/O 8-590, Convalescent hospital, 1 Apr 1942.

FM 101-10, Organization, technical and logistical data, 10 Oct 1943.

CENTRAL MEDICAL EXAMINING BOARD

Commanding generals of air forces and AAF independent commands will establish a Central Medical Examining Board. Such boards will be established at locations where Central Flying Evaluation Boards are appointed (see Sections 2-6 and 3-4).

Composition

The board normally will consist of 5 senior medical officers, either flight surgeons or aviation medical examiners, any 3 of whom will constitute a quorum. Wherever practicable, members of the board will include medical officers well trained in internal medicine, psychiatry, ophthalmology and otolaryngology. The president of the board will be the senior flight surgeon present.

Duties

A Central Medical Examining Board will consider the *physical* qualifications for flying duty of the following individuals when physical examination of such individuals is indicated:

1. All general officers of the command, except after grounding for minor physical incapacity or after a periodic examination for flying.
2. All commanding officers of air force stations or major tactical units of the command, with exception as noted above.
3. All officers under consideration for suspension from flying duty who exhibit undesirable habits or traits of character, lack of incentive for flying (combat or otherwise), emotional instability or inherent characteristics of personality which preclude continued useful flying duty.
4. All rated officers whose physical qualifications for flying cannot be definitely determined by the station or unit flight surgeon.
5. Such other officers as may be ordered to appear before the board by proper authority.

Records

Medical and other pertinent records concerning the individual will be forwarded to the president of the board by the unit commander or flight surgeon concerned. Such records will include a certificate from the unit commander that flying duty performed by the individual is unsatisfactory and to what degree; a complete history of the development of the individual's complaint; the unit surgeon's evaluation of the individual's adaptability for flying duty; any relevant statement made by crew members as to the individual's performance under stress; and a copy of a physical examination for flying accomplished some time within the preceding 30 days.

When final review is to be made at an air force or AAF independent command level, the physical examination record (WD AGO Form 64) will be forwarded in triplicate by the unit flight surgeon or president of a Central Medical Examining Board to the commanding general of the command concerned. The senior flight surgeon of the air force or AAF independent command will be required to forward an information copy of the report of physical examination with notation of the action taken thereon directly to the Air Surgeon.

A separate copy of the physical examination record will not be forwarded to the Air Surgeon when a copy is forwarded through command channels as a part of Flying Evaluation Board proceedings as outlined in paragraph 20b of AAF Regulation 35-16.

When final review and action is accomplished at Headquarters, AAF, the physical examination record will be forwarded in triplicate through command channels to the Commanding General, AAF, attention of the Air Surgeon, with the recommendations of the commanding general of the air force or AAF independent command concerned entered on the reverse side of the WD AGO Form 64 as an indorsement.

When the physical examination record is made a part of the Flying Evaluation Board proceedings, no comment will be made on the first indorsement of this record, inasmuch as an indorsement to the Flying Evaluation Board proceedings will contain the remarks and recommendations of the commanding general of the command concerned.

Policy

The Central Medical Examining Board is designed to provide at command level a specialized board of senior medical officers to whom appropriate cases can be referred for medical evaluation. Findings of the board will be limited to the determination of physical qualification or disqualification for flying duty in the capacity of the aeronautical rating or designation held. Although the board is designed primarily to consider the physical and mental qualifications of certain individuals performing unsatisfactory flying duty, the commanding general of a major command may order any member of his command to appear before the Central Medical Examining Board for the determination of medical qualification for

flying. Usually ordering the appearance of such individuals before the Central Medical Examining Board will be the result of a recommendation from the individual's unit commander who has acted upon the suggestion of his unit or station flight surgeon. The Central Medical Examining Board will not be used to relieve unit or station flight surgeons of the right and responsibility of making obvious judgments regarding medical qualification for flying. It is neither desired nor intended that the Central Medical Examining Board be used as an agency to which unpleasant or undesirable cases may be referred merely to relieve the unit or station flight surgeon from making judgments for which his background and training qualify him. The Central Medical Examining Board will not be used as a board of appeal from the decisions and judgment of the unit or station flight surgeon except in such cases as are ordered to appear before it by the commanding general of the major command.

Procedure

All rated individuals who are performing flying duty unsatisfactorily will be referred by the unit commander to the station or unit flight surgeon for a physical examination for flying. Likewise, when a rated individual on flying status indicates by actions or own request that he is unable to continue flying duty or that he has flying difficulties which may be associated with his state of health, he will be required to undergo a physical examination for flying.

When an individual's physical qualification for flying is in doubt or is difficult to ascertain, he will be recommended for reference to an appropriate Central Medical Examining Board for further study. Rated flying personnel who evidence undesirable habits or traits of character, inherent personality deficiencies or extremes in temperamental behavior which repeatedly interrupt or seriously interfere with required flying duties will be ordered before a Central Medical Examining Board if, in the opinion of the commanding general of the major command, the case should be considered by this body.

General Instructions

In considering an evaluation of an individual's fitness for flying duty, Central Medical Examining Boards will be guided by the general instructions outlined in AAF Reg. 35-16 and AAF Ltr. (c) 35-18.

Findings and Conclusions

Central Medical Examining Boards will limit their findings to an opinion as to whether the individual is physically qualified for flying duty in the capacity of the aeronautical rating held and an opinion as to the appropriate disposition of the case from the medical viewpoint. The report of the proceedings of the Central Medical Examining Board will be forwarded to the commanding general appointing the board who will take appropriate action concerning the individual. When a rated individual is ordered to appear before a Flying Evaluation Board, either local or central, after having appeared before a Central Medical Examining Board, the report of the latter board will be made available to the Flying Evaluation Board concerned and will constitute a part of its records and proceedings.

REFERENCES

AAF Reg. 35-16, Military personnel: flying status, suspension and removal of suspension from flying, restriction on flying, and evaluation of flying personnel, 20 Oct 1944.

AR 605-230, Reclassification, 9 June 1943.

WD Bulletin 35, Executive order 9195, 16 Jul 1942.

FLYING EVALUATION BOARD

A Flying Evaluation Board is a board of investigating officers appointed for the purpose of studying *professional* qualifications of rated flying personnel who hold currently effective aeronautical ratings and of making recommendations regarding their future utilization.

The Flying Evaluation System of an air force or independent command will be comprised of a *Central* Flying Evaluation Board and *Local* Flying Evaluation Boards. Commanding generals of air forces and independent commands will appoint a Central Flying Evaluation Board and will authorize the appointment of Local Flying Evaluation Boards as they see fit. A Local Board will be appointed at each major air base by the commanding officer thereof. Central Boards will be appointed by the Commanding General, AAF, for the examination of commanders of air forces, independent commands, and activities *not* covered by AAF Reg. 35-16.

Composition

Central Flying Evaluation Boards normally will consist of 7 officers, 4 chosen from the senior rated officers, 2 from the flight surgeons or aviation medical examiners of the headquarters who usually will be serving concurrently as members of the Central Medical Examining Board. When possible one officer with legal training will act as recorder of the board without vote. A quorum will be constituted by 3 of these officers, provided 2 are rated officers and one is a flight surgeon or aviation medical examiner. In the appointment of this board the A-1 and A-3 sections of the headquarters will be represented.

Local Flying Evaluation Boards will be appointed in a similar manner from officers available at the station where located.

Duties

Flying Evaluation Boards will be convened and submit reports under the following conditions:

1. In considering the suspension from flying of all individuals when such suspension requires confirmation of higher authority, except in cases where this suspension has been recommended on the basis of a physical disqualification for flying duty.

2. Prior to removal of suspension from flying duty of all individuals, except in cases of "temporary suspension" for reason of physical incapacity. In cases involving the removal of an "indefinite suspension" imposed on the basis of a physical incapacity which has been in effect for more than 6 months, the report will contain recommendations regarding the types of flying duty which the individual may perform and any restrictions which should be imposed.

3. When the flying proficiency of an individual has changed to a degree indicating a need to restrict his flying activities or when it is considered desirable to remove a previously imposed restriction.

Central Flying Evaluation Boards will not take final action in any cases. Functions of such boards include the following:

1. Review of such Local Flying Board reports as may be referred to them by the commanding general of the air force or independent command. Reports which are considered to be incomplete or inconsistent may be returned to the local board for reconsideration or further action, or recommendation may be made that the individual concerned be ordered to appear before the central board.

2. Recommendations of proper action to be taken by authorized officers in the above cases.

3. The investigation of such individuals as may be ordered to appear before the Central Board, and the preparation of recommendations as to action to be taken by officers authorized to take such action in each case.

Procedure and Records

Flying Evaluation Boards will be conducted in accordance with AR 420-5, and reports will be prepared on WD AC Form No. 7, "Flying Evaluation Report," approved 9 May 1941, or revision thereof. The individual whose qualifications are being investigated will be allowed to appear before the board, to calling witnesses in his behalf, and to crossexamining witnesses who testify against him, and to be represented before the Board by counsel if he so desires.

A copy of WD AGO Form 64 of the individual concerned will be attached as an exhibit to each copy of a Flying Evaluation Board report in all cases (except those being investigated for suspension on change of MOS and or reassignment) as evidence that final determination of physical condition was established prior to initiation of Flying Evaluation Board proceedings.

In cases of "indefinite suspension" for professional disqualifications which are anticipated to be for a period of 6 months or more, recommendations of Flying Evaluation Boards shall include one of the following:

1. That the individual be "indefinitely suspended" from flying and that he be allowed to wear the aviation badge.

2. That the individual be "indefinitely suspended" from flying and that he not be allowed to wear the aviation badge. This recommendation will be made in all cases involving clearly substantiated refusal to fly, fear of flying, or fear of combat unless the evidence established the fact that his fear is the direct result of particularly harrowing experiences.

Disposition of Reports

Reports of Local Flying Evaluation Boards which are under the jurisdiction of a continental air force or independent command will be forwarded through command channels for review at the air force or command headquarters in all cases. Reports of Local Boards not under the jurisdiction of a continental air force or command will be forwarded through command channels to Headquarters, AAF. Reports of Local and Central Boards, with action recommended by the commanding general of the air force or independent command appearing thereon, will be forwarded to Headquarters, AAF, for all cases in which the commanding general of the air force or command is *not* authorized to take final action.

REFERENCES

AR 420-5, Board of officers for conducting investigations, 20 May 1940.

AAF Reg. 35-16, Flying status, suspension and removal of suspension from flying, restriction in flying, and evacuation of flying personnel. 20 Oct 1944.

MEDICAL DISPOSITION BOARD

The hospital commander is responsible for the disposition of patients, and to aid him in these matters he may appoint a board of 3 or more medical officers to be known as a Medical Disposition Board. Although any hospital may have a Medical Disposition Board, only at AAF convalescent hospitals and AAF regional hospitals are Disposition Boards granted the right of physical reclassification.

Selection of Cases for Appearance Before a Medical Disposition Board

The selection of cases for appearance before a Medical Disposition Board is the responsibility of the chiefs of sections and chiefs of services in an army hospital. Boards should confine themselves strictly to their proper fields, the evaluation of the physical fitness of the examinee, and should not be influenced by any other consideration. The phrase "physically fit for full military duty" means fitness for the performance of the duties appropriate to the grade of the examinee concerned. An elderly staff officer may be quite incapable of a 30 mile march but still be physically fit for full military duty. The board makes no recommendations concerning the physical qualification of an officer for flying duty. However, there is no objection to the board giving in the body of its report any information about the patient that may be useful to the flight surgeon in deciding proper disposition.

A common error of Medical Disposition Boards is to confuse administrative and medical matters. The board is a medical agency for the disposition of the sick and injured and is to be used for no other purpose. It is not to be used as an agency to dispose of the maladjusted, the inadequate, and the disgruntled, and it must not be turned into an easy channel of escape for the sick in spirit and the psychopathic personalities, and those who are so unmindful of their obligations and duty that they will seize any opportunity to escape the tedium of service. Officers who are unable to adjust themselves satisfactorily to the conditions of their service or who, because of defects of personality or character, bad habits or lack of professional qualifications, are unable to discharge the duties of their office, must be dealt with administratively. In general an officer will be brought before a Medical Disposition Board when:

1. There is a question as to the line of duty status of his illness, provided the provisions of AR 345-415 do not apply.

2. There is uncertainty as to the future course of the disease or injury which may result in partial or complete disability and eventually be made the basis of a claim against the government.

3. Admission was for mental observation.

4. The officer believes he is at a lower level of physical efficiency than when he entered on active duty.

Officers should appear before a Medical Disposition Board having the power of physical reclassification when:

1. Admitted or transferred to the hospital for determination of the type of duty they are physically qualified to perform.

2. When the contemplated disposition is a return to duty with recommendations limiting the type of activity or the place of service.

3. When physical reclassification from general to limited service, or from limited to general service is required.

4. When retirement for physical disability is contemplated.

5. When a diagnosis of a constitutional psychopathic state has been made and it is planned to return the officer to duty for the purpose of appearing before a reclassification board in accordance with the provisions of AR 605-230.

Proceedings

Officers who appear before a Medical Disposition Board should be clinically studied in as great detail as the particular case indicates. Following such study, a concise clinical summary should be prepared for presentation to the board. An officer who is familiar with the case, usually the ward officer, presents the patient and all available data to the members of the board. The proceedings are informal. Neither the members of the board nor the patients who appear before it are required to testify under oath. The patient should be given an opportunity to make statements and to ask questions concerning his medical status. However, specific information concerning duty limitations and fitness for overseas assignment should not be disclosed to the patient by members of the board, as it is to be constantly borne in mind that the board acts in an advisory capacity and does not take final action. It is essential that all medical officers concerned with the disposition of patients be thoroughly conversant with the provisions of all directives concerning the utilization of manpower based on physical capacity. Diagnoses recorded in the proceedings of a Medical Disposition Board should conform as nearly as possible with the terminology found in AR 40-1025. Line of duty status should be determined in accordance with current directives, particularly AR 345-415, AR 35-1440, and WD Circ. 458. Any residual disability and the individual's fitness for overseas assignment should be clearly indicated. The recommendations of the board should be supported by the facts recorded in the clinical summary. The degree and duration of the disability in a given case must be carefully considered in arriving at a recommendation. It is inconsistent to make a finding of a "temporary disability" and then recommend "permanent physical reclassification to a limited service status."

Records

The proceedings of the Medical Disposition Board will be recorded on WD AGO Form 8-118. This form will be accomplished in quintuplicate for distribution as follows:

1. Those cases in which the officer concerned is returned to duty:

a. The original and one copy will be forwarded to the Adjutant General, through the Commanding General, AAF (Attention: the Air Surgeon).

b. One copy, addressed to the commanding officer of the station of assignment, attention the surgeon, will be placed in a sealed envelope and forwarded or carried by the officer concerned to the station to which he returns to duty.

c. One copy will be placed on file with the clinical record (MD Form 55 series).

d. One copy will be placed in the hospital files.

2. Those cases in which the officer concerned is to appear before the Army Retiring Board at the medical facility where such recommendation was made:

a. The original and two copies will be forwarded to the president of the Army Retiring Board at that facility.

b. The fourth and fifth copies will be distributed as outlined in c. and d. above.

3. Those cases in which the officer concerned is considered a candidate for Retiring Board procedure but who meets a Medical Disposition Board at a facility at which a Retiring Board is not constituted:

a. The original and two copies will be forwarded to the commanding officer of the medical facility having an Army Retiring Board to which the individual is transferred.

b. The fourth and fifth copies will be distributed as outlined in c. and d. above.

(NOTE: In these cases the recommendation of the board will be as follows: "The board recommends that Captain John E. Doe be transferred to .... Hospital for further study to determine the appropriateness of recommending his appearance before an Army Retiring Board.")

4. In those cases where the commanding officer of a station which has a Medical Disposition Board authorized the right of physical reclassification does not concur with the recommendations of the reconvened Medical Disposition Board:

a. The original and two copies will be forwarded direct to the Air Surgeon for decision.

b. The fourth and fifth copies will be distributed as outlined in c. and d. above.

Action on Board Proceedings

Commanding officers of stations having regional

hospitals and convalescent hospitals designated by the War Department have the authority to act on the recommendations of a Medical Disposition Board without further reference to higher authority. The only exception to this procedure is in those cases where the commanding officer of such a station does not concur with the findings of a reconvened Medical Disposition Board. In those instances the proceedings of the Board will be forwarded to the Air Surgeon for appropriate action.

After an officer appears before a Medical Disposition Board, he may be:

1. Ordered to return to a station or unit of assignment.

2. Ordered to appear before the Army Retiring Board at that facility.

3. Transferred to the nearest medical facility where an Army Retiring Board is constituted.

4. Ordered to another medical facility for specialized treatment.

5. Remain as a patient in the hospital pending action by higher authority when the commanding officer of the facility does not concur with the findings of the reconvened Medical Disposition Board.

The orders returning an officer to duty from a medical facility will clearly state his physical classification status.

REFERENCES

AR 40-590, Administration of hospitals: general provisions, 29 Aug 1944.
WD Cir 403, Physical reclassification of officers, 14 Oct 1944.
AR 345-415, Daily sick report, 23 Nov 1933.
AR 605-230, Reclassification, 9 June 1943.
AR 40-1025, Records of morbidity and mortality, 12 Oct 1944.
WD Cir 458, Determination of line of duty, 2 Dec 1944.
AR 35-1440, Loss of pay during absence due to diseases resulting from misconduct, 15 Nov 1933.

ARMY RETIRING BOARD

Army Retiring Boards are appointed by direction of the President of the U. S. through the Secretary of War, but the authority has been delegated by the Secretary of War to the commanding generals of Service Commands within the continental U. S. and to the Commanding General, AAF.

Constitution

An Army Retiring Board assembled to hear a given case will have a quorum of at least 5 members and not more than 9 members present. Two-fifths of the officers present in such a quorum will be in the Medical Corps. Although the quorum places certain limitations on the number of members who shall hear a given case, this will not be construed to prohibit the appointing authority from designating members in excess of this number. The president of the board can excuse certain members in order to obtain a legal quorum. Particular attention must be given to the number of Medical Corps officers serving. Any variation from the ratio of medical officers to line officers results in an illegally constituted board and its findings are invalid.

Officers appointed to serve as members will, insofar as possible, be personnel who have mature judgment and are well versed in the laws, regulations and policies concerning the separation of officers from the service by reason of physical disability.

The recorder usually conducts the case for the government. This officer is not a member of the board and will not participate in the deliberations or discussions of the board while it is in closed session.

Witnesses

Medical witnesses are designated by local order in accordance with instructions received from the appointing authority. Medical officers detailed for this purpose should be well qualified professionally and well versed in the administrative details set forth in directives governing the conduction of Army Retiring Board proceedings.

Function

An Army Retiring Board is a fact finding body and has such powers of a court-martial and of a court of inquiry as may be necessary to determine the facts concerning the nature and occasion of the disability of officer personnel.

Proper cases for determination by an Army Retiring Board are those in which:

a. Officers may be considered physically or mentally incapacitated for active service regardless of whether such incapacity is or is not the result of any incident of the service.

b. Officers of the Regular Army are classed as physically disqualified as a result of physical examination required for promotion in permanent grade.

Officers are directed to appear before the Army Retiring Boards only in, or in compliance with, orders issued by the War Department. Such orders may be in the form of instructions to subordinate commanders who will issue the necessary orders thereunder.

Procedure

Officers ordered to appear before an Army Retiring Board may be represented by military or civilian counsel. However, in all cases in which the officer is adjudged to be mentally incompetent, he will be represented by military counsel appointed by the appointing authority. Officers being heard may challenge any member of the board and may introduce objection to any action taken or proposed to be taken by the board. He may testify as a witness in his own behalf, may introduce testimony of witnesses and may cross-examine witnesses examined by the board. The entire proceedings of the board are to be conducted in such a manner that a full and fair hearing is granted to officers appearing before it.

Medical corps officers who are detailed as witnesses shall examine the officer concerned prior to the meeting of the board. In addition to the findings elicited at the time of physical examination, all medical records pertaining to the officer concerned should be carefully examined and evaluated. The testimony presented to the board should be based upon the decisions arrived at after a thorough clinical study of the individual and an examination of all available records and documentary evidence. Every effort should be made to arrive at a finding based on fact. It is highly desirable that in questionable cases the physician who attended an officer prior to his entrance on active duty be consulted for any information he can furnish about the previous health of the individual.

In testifying before the board, the medical witnesses should be prepared to state:

1. Whether the officer concerned is or is not incapacitated for active service (active service is interpreted to mean general military service).

2. The diagnosis of the disability which incapacitates the officer concerned (official nomenclature to be employed).

3. Whether the incapacity is or is not an incident of the service as an officer, bearing strictly in mind that any permanent aggravation of a pre-existing disability during the current tour of duty is considered an incident of the service.

4. Whether the *cause* of the incapacity is or is not an incident of the service. An incapacity which originated prior to entrance on active duty and which has been permanently aggravated during the present tour of duty is incident to the service. However, the cause of the incapacity in this case will be found to be not incident to the service.

5. The date on or about which the officer became incapacitated for active service.

6. Whether the incapacity is or is not permanent. An incapacity has been interpreted to be permanent when it will require treatment over a period of time in excess of 2 years.

7. Whether the officer, if considered physically disqualified for further active service, is physically qualified for limited service.

Although the medical witnesses usually present all medical testimony, medical members of the board may examine the officer and testify before the board as to their findings. After all testimony has been received in a given case, the board is closed to deliberate upon the case and arrive at certain findings as follows:

1. That subject officer is or is not incapacitated for active service.

2. That the incapacity is or is not incident to the service.

3. That the cause of the incapacity is (name the diagnosis and disability).

4. That the cause of the incapacity is or is not incident of the service and originated on or about (here state date).

5. That the incapacity is or is not permanent.

A minority report can be forwarded with the findings in those cases in which the findings of the board are not agreed upon unanimously.

Disposition of Proceedings

The proceedings of the board in the case of officers of the AAF, including officers of the Arms and Services on duty with the AAF, will be forwarded to the Commanding General, AAF, for transmittal to the Adjutant General, through the Surgeon General. Following review by the War Department, the proceedings are transmitted to the Secretary of War for final approval or disapproval by the President of the United States.

If the approved proceedings recommend retirement, the orders directing retirement and placing the officer on the retired list are accomplished by the Adjutant General.

Special provisions to be used by the Retiring Boards in the case of retired officers, subsequently called to active duty and incurring a new disability while on active duty, are contained in WD Bulletin No. 12, 7 July 1943.

REFERENCES

AR 605-250, Army retiring boards, 28 Mar 1944.

WD Bulletin 12, Appropriation—for military establishment, fiscal year 1945, and other purposes, 6 Jul 1944.

FLIGHT SURGEON'S RECLASSIFICATION BOARD

Whenever a medical officer shows by evidence of misconduct, inefficiency or related cause that he cannot properly perform the duties of an aviation medical examiner or a flight surgeon and that his rating should be revoked, the surgeon of the next higher echelon of the command will report the facts to the Commanding General, AAF, through command channels. The Commanding General, AAF, will appoint an Investigating Board of 3 or more flight surgeons whose appointment, actions and procedure will be governed by the provisions of AR 420-5.

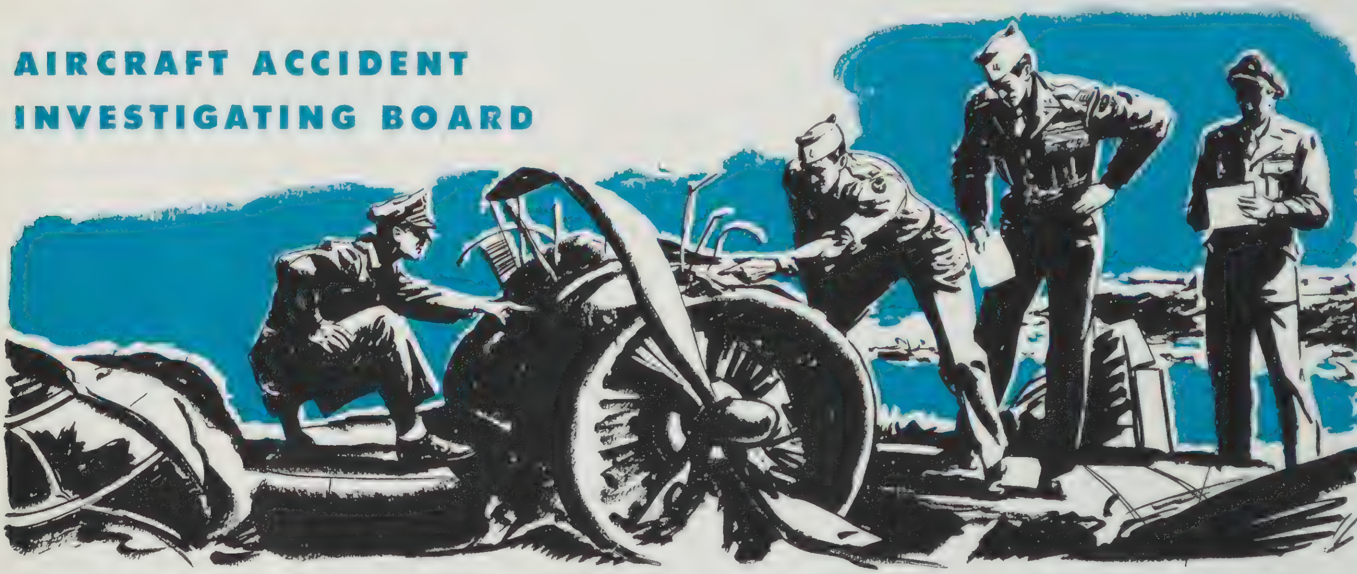
The individual being investigated should not be denied counsel if he desires it.

If after the report of the Investigating Board and reviewing authority, it is determined that the rating should be terminated, revocation will be accomplished on the authority of the Commanding General, AAF.

REFERENCES

AAF Reg 35-52, Designation of aviation medical examiner, flight surgeon, and flight nurse, 13 Apr 1944.
AR 420-5, Board of officers for conducting investigations, 20 May 1940.
WD Circ. 98, Designation of aviation medical examiners, flight surgeons, and flight nurses, 8 Mar 1944.

AIRCRAFT ACCIDENT INVESTIGATING BOARD



The Commanding Officer of each air base will appoint a board to investigate all major accidents (see Sections 5-2 and 8-8). This board will consist of the following members:

1. Two pilot officers possessing outstanding experience.
2. One officer possessing wide engineering experience.
3. An intelligence officer who will be an ex-officio non-voting member and whose duty will be to determine possible sabotage.
4. A medical officer, preferably a flight surgeon or aviation medical examiner, who will be recommended to the commanding officer by the base surgeon. This medical officer will serve as an ex-officio non-voting member of the board. An alternate medical officer member shall be designated to serve in the absence of the regular medical investigation officer.
5. One or more officers from the Office of Flying Safety who will serve in an ex-officio capacity.

It is the duty of this board to determine all facts concerning the accident. The investigation and the reporting of data will follow procedures laid down in the "Aircraft Accident Investigators' Handbook." This publication gives complete directions for the completion of AAF Form 14 by the Board, and AAF Form 205 by the medical investigating officer (see Sections 5-2 and 8-8).

Minor accidents are investigated by the station accident officer, not by the board. Minor accidents, that is, those which result in minor injury to persons or minor damage to the aircraft, are therefore not required to be investigated by a medical officer.

REFERENCES

AAF Manual 62-1, Aircraft accident investigator's handbook.

SECTION 4

TRANSPORTATION OF PATIENTS

SECTION 4

TRANSPORTATION

1. Chain of Evacuation.

2. By Land and Water.

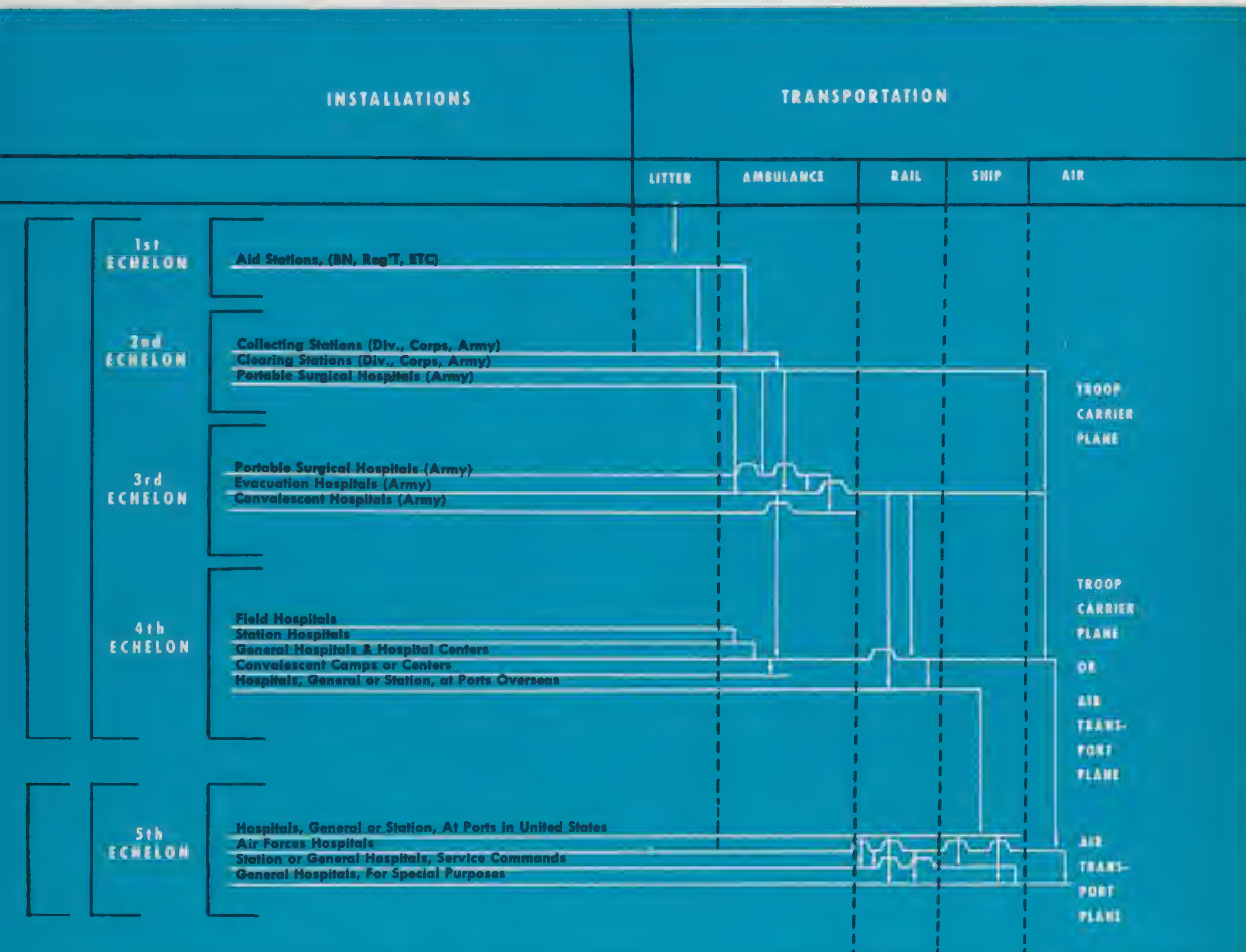
3. Evacuation by Air.

CHAIN OF EVACUATION

The chain of evacuation of sick, wounded, and injured from the combat zone to the zone of interior is summarized in the accompanying charts.

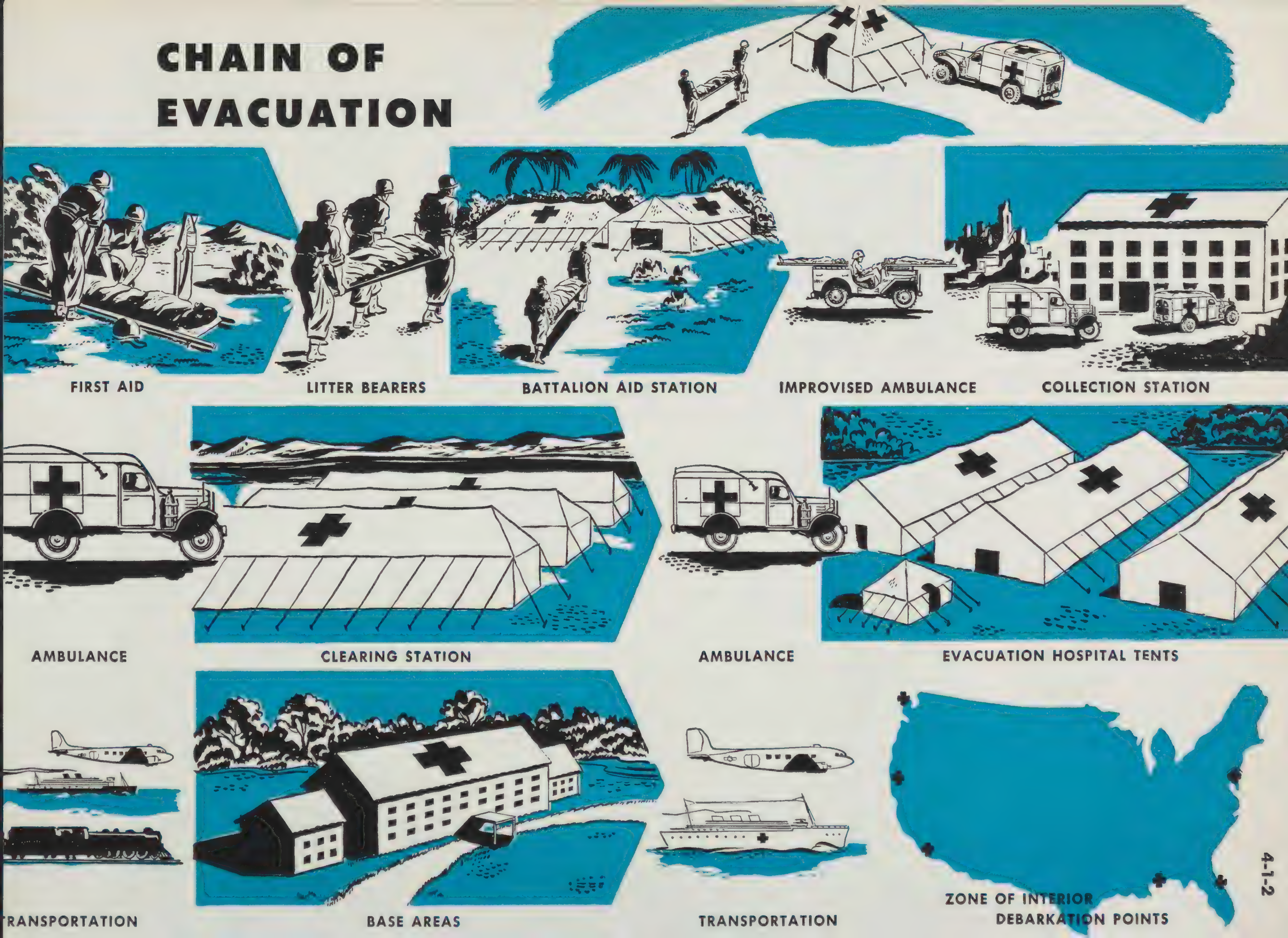
The general evacuation policy is made by the War Department at the recommendation of a theater commander, although the plan of evacuation will necessarily vary greatly with the tactical situation. Thus wounded in theaters may be flown directly from a clearing station to a general hospital in the interior.

Necessary changes or improvisations are handled by the "medical regulating officer" who has information concerning the number of casualties, the types of transportation facilities at hand, and the number of beds available.



NOTE: At each medical installation, the physically fit are separated from those requiring further treatment, the former being returned to duty through replacement channels and the latter being evacuated or retained for further treatment. In general, patients in overseas hospitals who require treatment for more than 120 days are evacuated to the zone of interior as soon as practicable.

CHAIN OF EVACUATION



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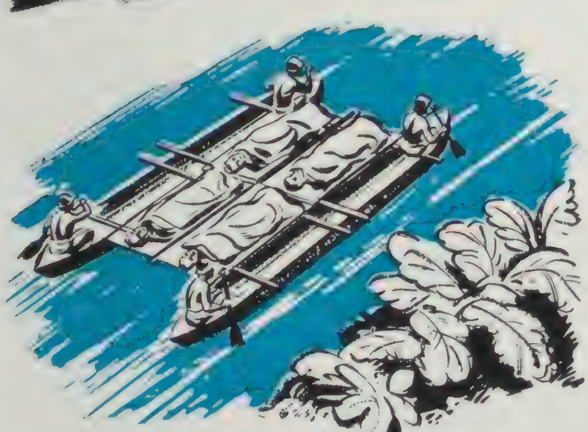
BY LAND AND WATER

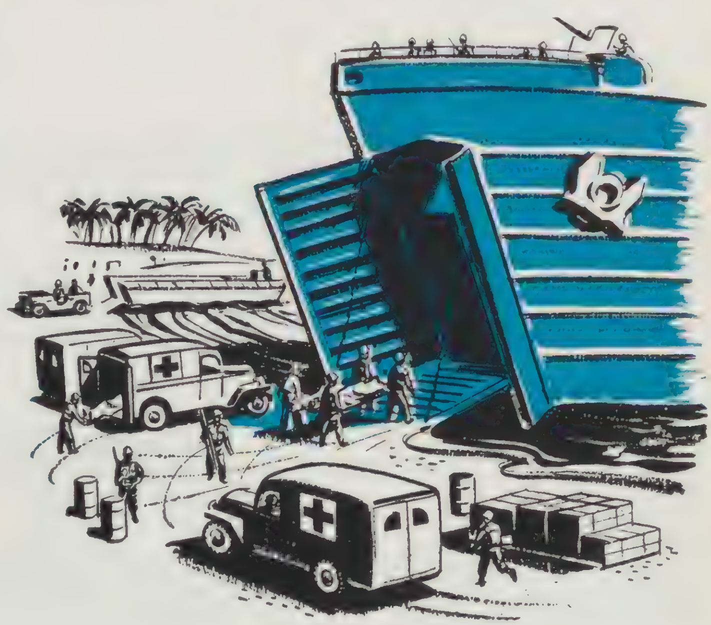
The transportation of sick and wounded may be accomplished by manual transport, by litter, by jeep or truck, and by rail. Details of these methods of evacuation are found in FM 8-35.

For transportation by water, any floating conveyance may be used as the situation requires. From beachheads a good part of the evacuation is carried on by the LSTs and the LSIs, and various other types of landing craft. Larger water transports include the hospital transport or ambulance, a ship which is usually a converted commercial vessel; the hospital ship, a large converted passenger or cargo vessel equipped to treat casualties; and the fleet hospital ship, a vessel designed specifically for hospital care which may be regarded as a floating general hospital.

REFERENCES

FM 8-35, Transportation of sick and wounded, 21 Feb 1941.





EVACUATION BY AIR

Carrier wing, group, or squadron serving in the particular theater or defense command.

Use of AAF equipment is limited to aircraft and the litter stanchions or web straps. Oxygen equipment for therapeutic purposes during evacuation has been suggested and when further developed will be provided as standard equipment.

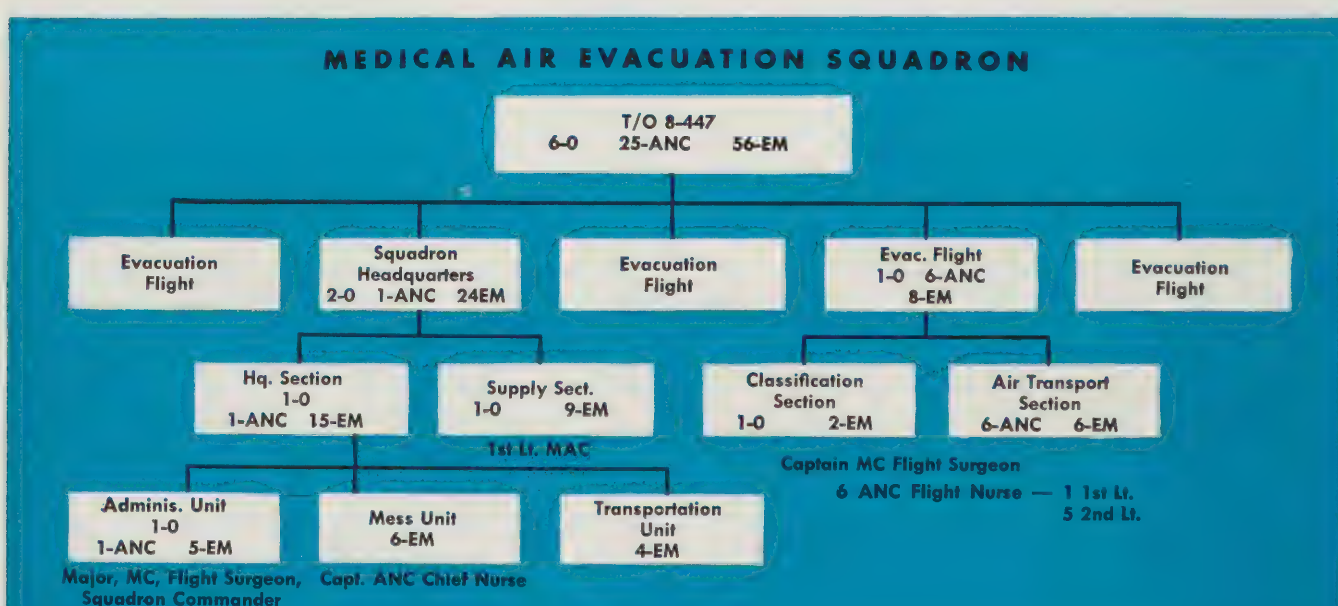
Medical Department equipment is provided for each aircraft in the form of an air ambulance case which contains drugs, bandages, hot cups, and other materials for the nursing care of patients en route (see Section 6). Additional equipment may be provided as needed for patients' comfort (electric blankets, bed rolls, etc.). Such equipment as litters and blankets are taken care of by the usual method of property exchange.

Units and Equipment Employed

The AAF provide aircraft, crews, and suitable landing fields within a theater. In a theater, Troop Carrier units supply aircraft and flight personnel; the Medical Department supplies medical equipment and specially trained medical personnel. The latter are organized into specialized units designated as medical air evacuation squadrons, under the command of a major, Medical Corps, flight surgeon, assisted by four additional flight surgeons, 25 flight nurses, and 61 enlisted men. This unit is normally attached by air force headquarters to the Troop

Plan of Evacuation

In those areas where large numbers of AGF troops are engaged in combat and the need for air evacuation is evident, close coordination among the theater commander, the air commander, and their surgeons



ORGANIZATION OF THE MEDICAL (T/O and E 8-447) AIR EVACUATION SQUADRON

is required for the establishment of a workable plan. In general, the air force, through the Troop Carrier unit and the medical air evacuation squadron, will provide aircraft, personnel, and a suitable airfield. The AGF will provide medical facilities for the care of casualties within a few minutes driving time of these airfields, sometimes designated a "holding evacuation points." Airfields will be selected primarily for their suitability as distributing points for supplies and personnel, since that is the primary mission of the transport aircraft. The number of aircraft and frequency of flights will be determined by the Troop Carrier unit commander and this information coordinated through the air force surgeon to flight surgeons of the medical air evacuation squadron at evacuation points. Maintaining close liaison with the AGF medical officers, the flight surgeons will select patients to be evacuated on return flights. In the meantime, the theater surgeon will have made arrangements for the hospitalization of the returning casualties at evacuation or general hospitals within his jurisdiction.

Priorities of Evacuation

Proper selection of cases by medical personnel is an important consideration in the application of aircraft to the task of evacuation. Therefore whenever possible, flight surgeons will select patients to be evacuated by air, giving due consideration to all possible aero-medical problems involved. The necessity for air evacuation from a theater will be guided by the following factors:

1. Emergency cases for whom essential medical treatment is not available locally.
2. Casualties for whom air evacuation is a military necessity.
3. Casualties for whom prolonged hospitalization and rehabilitation are indicated.
4. Patients suffering from certain diseases which can be improved only by treatment other than that available locally.
5. Casualties for whom surface facilities cannot be provided because of the military situation.

Experience has shown that patients fall into three major categories which may be considered priorities for air evacuation:

Priority I. Those requiring major nursing care.

Priority II. Those requiring minor nursing care.

Priority III. Those requiring no nursing care.

In emergencies, air evacuation being available and feasible, all cases regardless of type will be evacuated by air.

Evacuation from a Theater to the Zone of Interior

The Air Transport Command is responsible for air evacuation from a theater or defense command to the zone of interior. The Air Transport Command accomplishes this mission by means of transport planes operating under the technical control of Air Transport Command wings, which maintain routine schedules of transport planes to all theaters and defense commands. To each Air Transport wing is assigned, where necessary, one or more medical air evacuation squadrons to provide medical service for all casualties evacuated by air.

Priorities for the evacuation of casualties to the zone of interior are established by the Priorities Division, Air Transport Command, in coordination with the Air Surgeon. Once placed aboard an Air Transport Command plane, a patient retains his priority for transportation during the flight to the zone of interior terminus of the Air Transport wing.

Action to transport casualties by air to the U. S. originates with the theater or defense commander. Representatives of these commanders (who are commanding officers of theater or port hospitals) communicate directly with the wing commander of the Air Transport wing operating in that particular theater or base. The report to the wing commander includes the following data:

1. The station on the Air Transport Command route where patients are concentrated for air evacuation to the zone of interior.
2. The number and type of patients to be evacuated by air.

The actual coordination and operation of air evacuation from the theater to the zone of interior is the responsibility of the commanding general, Air Transport Command wing, who is assisted by the wing surgeon.

Evacuation Within the Zone of Interior

Casualties evacuated by air from a theater or defense command, are brought into the U. S. at terminals of the Air Transport Command wings, at which are located AAF bases with hospital facilities available for immediate hospitalization. From these hospitals casualties are distributed to various General Hospitals within the zone of interior by means of rail, motor, or further air evacuation, depending upon the circumstances. In some instances movement by air from a theater may be direct from the overseas base to a zone of interior general hospital.

Casualties occurring within the zone of interior itself, either because of the peculiar nature of the case or the isolated character of its location, may also be evacuated by aircraft to a civilian or military hospital.

Triage and Principles of Aerotherapeutics

Experience gained principally in this country has demonstrated that *any* case, regardless of type, can be transported by air, provided the plane is equipped with adequate facilities and the medical personnel aboard are trained in the principles of aerotherapeutics.

Principles of Aerotherapeutics:

The principal physiological changes in flight which must be dealt with in treating patients are the decrease in partial pressure of oxygen and the expansion of air or gas trapped in any of the cavities of the body (see Section 8).

Certain types of casualties require additional oxygen at altitudes below 10,000 feet because of the anoxia caused by disease or injury. The alveolar membranes may be damaged, as in pneumonia, impeding the passage of oxygen from the alveoli to the blood (anoxic anoxia). The transportation of oxygen may be inadequate in anemias and malaria (anemic anoxia). The whole column of blood may move too slowly to carry oxygen in sufficient quantity to the tissues, as in circulatory collapse, caused by "shock" or cardiac failure (stagnant anoxia). Finally, the tissues themselves may be so damaged that they are unable to utilize the oxygen as in certain types of poisonings and alcoholism (histotoxic anoxia). Any of these factors, added to the decrease in oxygen pressure on ascent, makes it necessary to supply supplementary oxygen from the ground up.

Air or any gas trapped in the cavities of the body is subject to expansion in proportion to the decrease in pressure (see Section 8-2). This increase in volume becomes significant at 15,000 feet where the volume of air or gas trapped in the body is about doubled. For the abdominally wounded man this increase might cause rupture of a recently sutured intestine or abdominal wall.

Application of Principles:

Head injuries. Severe concussions and fractures of the skull frequently result in decreases in oxygen saturation of the blood of 4% to 44%. Therefore, at any altitude, oxygen should be administered to these cases.

Thoracic injuries. Anoxia should be the first consideration of any serious thoracic injury. All such cases should receive 100% oxygen at any altitude. In pneumothorax of the closed or ball valve type, untoward results on ascent may be relieved by thoracentesis.

Abdominal wounds. The airplane ambulance chest (see Section 6) is equipped with duodenal and colonic tubes for use in facilitating the escape of expanded gas. The factor of anoxia should also be considered, if the distention is great, and the diaphragm elevated.

Malaria and other anemias. Supplementary oxygen should be used as needed.

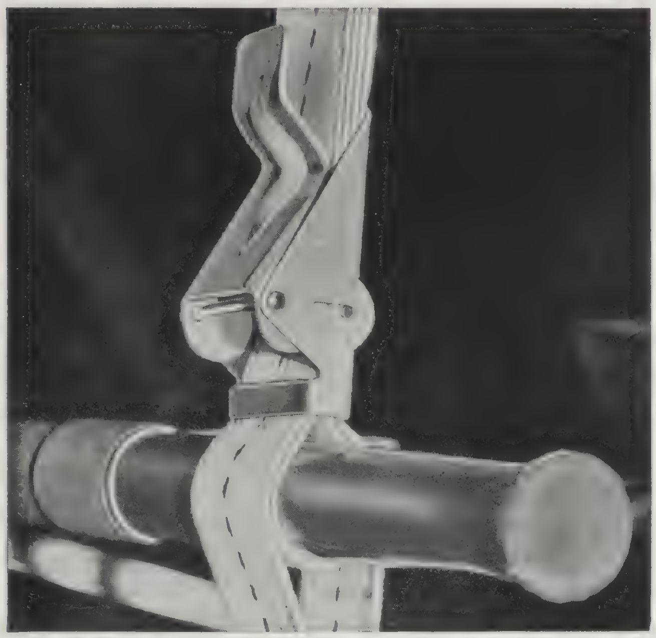
"Shock." All the standard methods of treatment that can be given on the ground can be given aboard a well-equipped air evacuation plane. Plasma and intravenous fluids are available and their administration is possible and practical. The standard shock position is made possible by special bracket equipment which allows the patient's head to be lowered. Oxygen is available and blankets and special heating pads are part of the air evacuation equipment. Morphine is also available, but its use is contraindicated at very high altitudes because of its supposed interference with oxygen utilization.

A

LITTER INSTALLATIONS IN AIRCRAFT

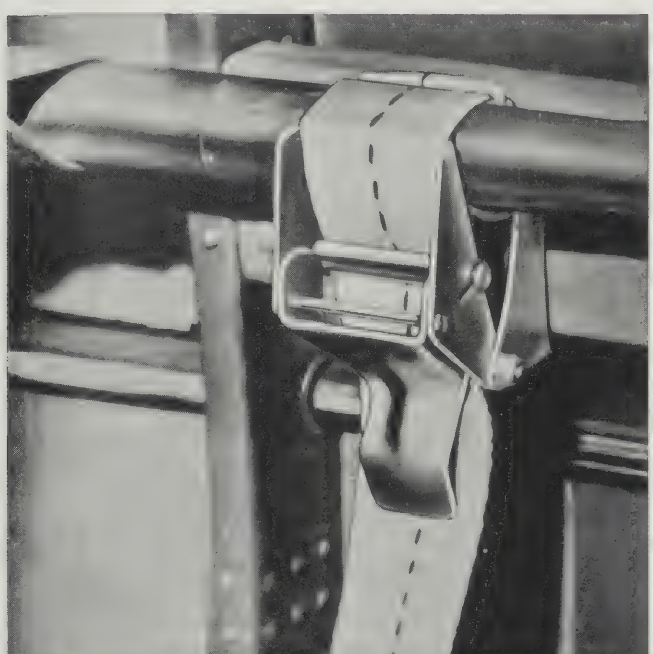
STANDARD LITTER SUPPORT INSTALLATION

The standard AAF litter support installation for cargo aircraft includes:



1. Parachute webbing straps hanging from the roof of the cargo compartment and containing loops for supporting the handles of inboard litter poles.

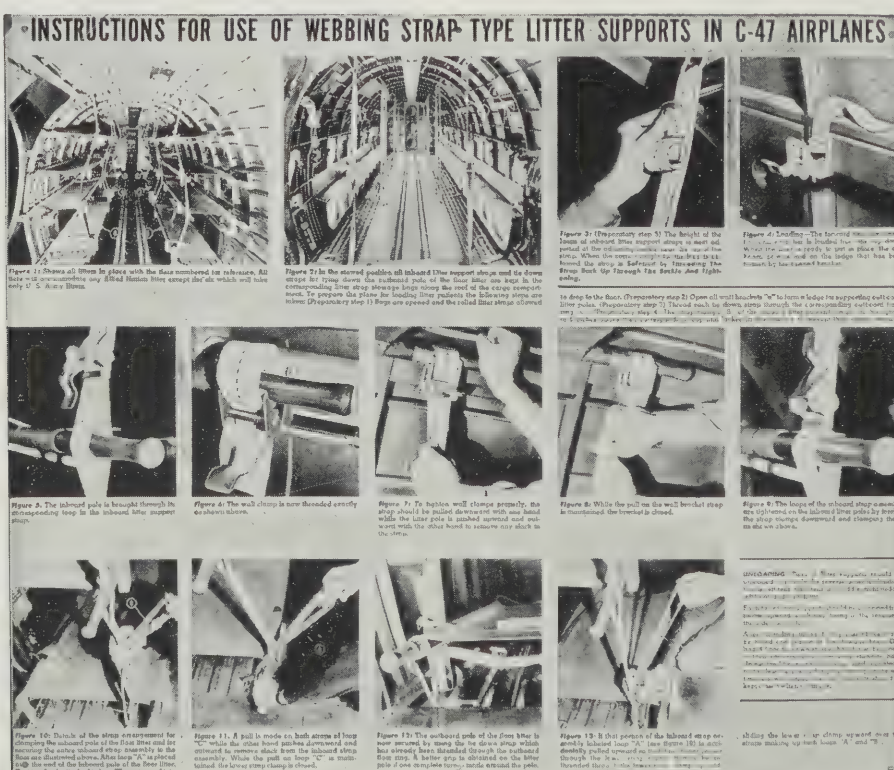
3. Adjustments for raising and lowering loops in the inboard straps to provide level litters.



2. Wall brackets which provide ledges for supporting and securing outboard litter poles.

4. Canvas bags for stowage of straps along the roof of the cargo compartment when litter supports are not in use.

5. Adjustments for tightening the entire inboard litter strap and for securing inboard poles of lower litter to the floor.



6. Illustrated placard showing patient-loading procedures. The standard method for preparing the webbing strap litter supports before transporting litter patients may be found in appropriate technical orders.

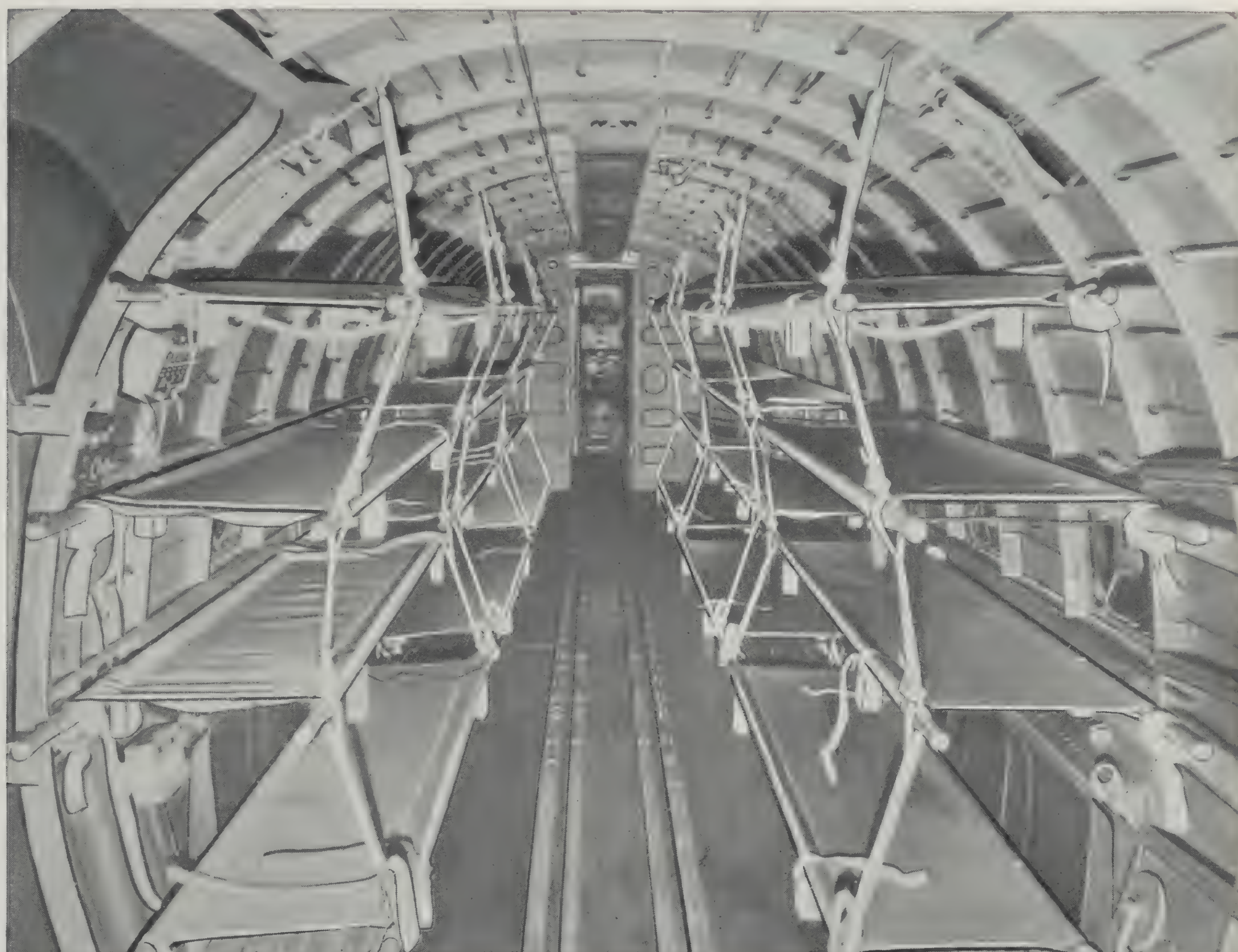
B AIRCRAFT EQUIPPED WITH STANDARD LITTER SUPPORTS

C-47

(Douglas "Sky Train" or British "Dakota")

The standard installation provides supports for 24 litter patients in 6 tiers, each tier being 4 litters high. All tiers, except the left rear, will accommodate U. S. Army Medical Department, British, and Australian pole type litters. The rear left tier can be made to accommodate only U. S. Army Medical Department pole type litters. Late models are also equipped with Evans type troop benches, which may be used as bunks by detaching the back rests.

For details of patient-loading techniques, see T.O. 00-75-1.



C-46

(Curtiss-Wright "Commando")

The maximum litter capacity is 24 litter patients, plus a maximum of 9 troop seats for medical attendants and ambulatory patients. The standard support installation differs from others in having outboard stanchions which support the wall brackets. When not in use the stanchions fold conveniently along the walls of the cargo compartment.

Late models are equipped with automatic continuous flow oxygen systems for passengers and patients at altitude, and Evans type canvas troop benches.

For details of patient-loading techniques for the C-46 see T.O. 00-75-2.

C-54

(Douglas "Sky Master")

The maximum litter capacity of standard webbing litter supports in various models depends upon the location of the floor bulkhead of the cargo compartment:

With 4 fuselage fuel tanks (C-54A)—20;

With 2 fuselage fuel tanks (C-54B)—28;

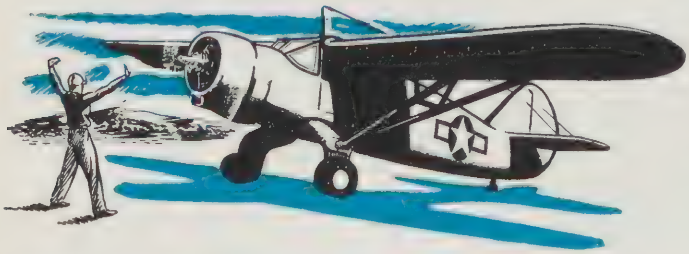
With no fuselage fuel tanks (C-54G)—36.

All C-54Bs and many C-54As are equipped with Evans type canvas troop benches which hang or roll conveniently against the wall when not in use.

For details of patient-loading techniques for C-54 aircraft see T.O. 00-75-4.

A small number of C-54As are equipped with Evans stanchion type litter supports. These provide a maximum capacity of 24 litters per airplane. When not in use the stanchion assemblies are folded upward and stowed in clamps along the roof of the cargo compartment.

C-64

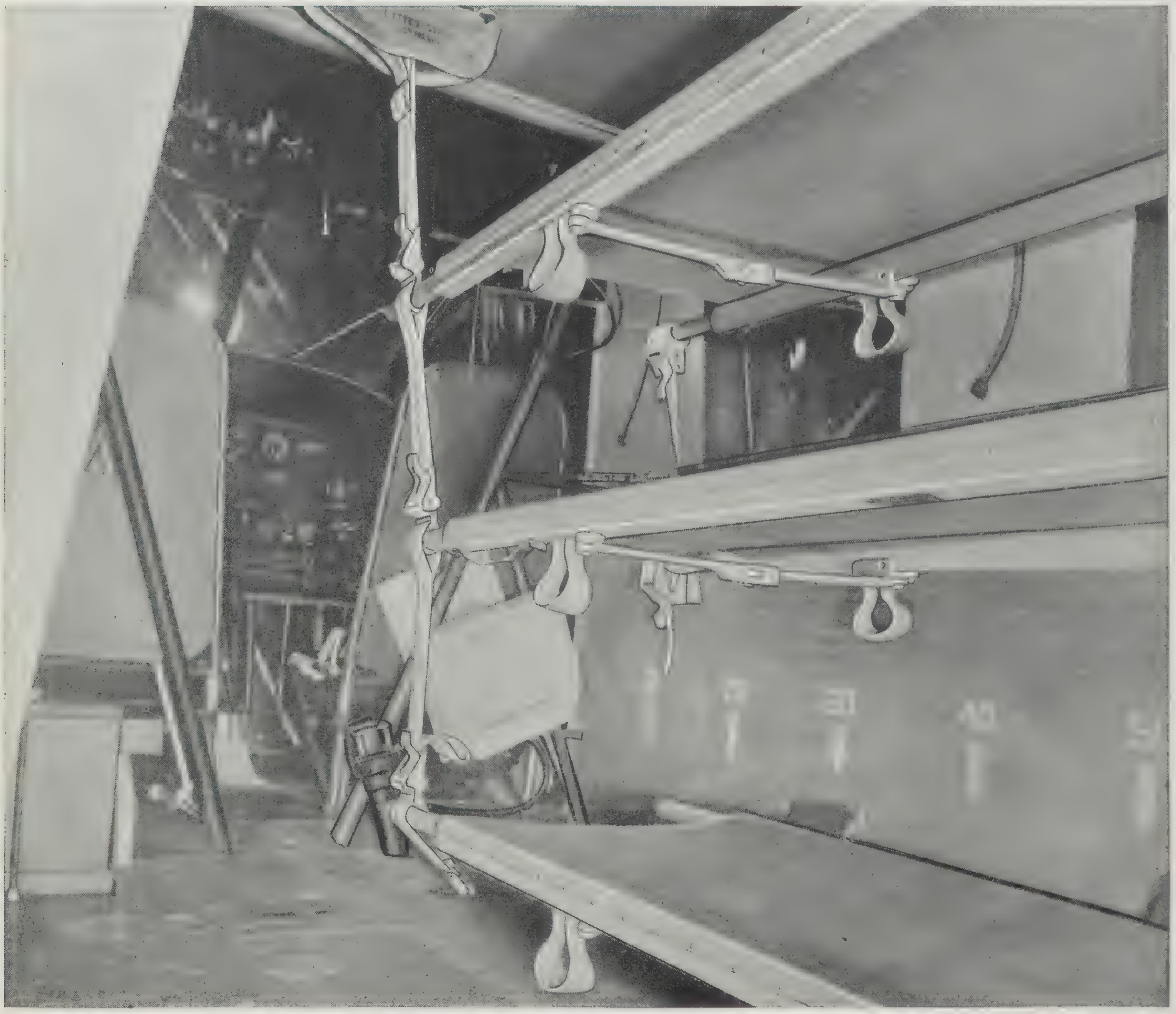


(Noorduyn "Norseman")

This small cargo aircraft has a normal litter capacity of 3 litter patients and 2 ambulatory patients in addition to the pilot and medical attendant. The litters are supported along the right wall of the cargo compartment and the ambulatory patients are transported on a small troop bench at the rear of the cargo compartment. A floor litter may be transported in the aisle opposite the tier of three litters, provided both floor litters are U. S. Army Medical Department type and provided the patients can be loaded onto the litter after it is in place in the aircraft.

The cabin is well insulated and heated for Arctic operations but no oxygen is permanently installed. Ski and float models are also available. A large cargo door is provided for easy loading of litter patients.

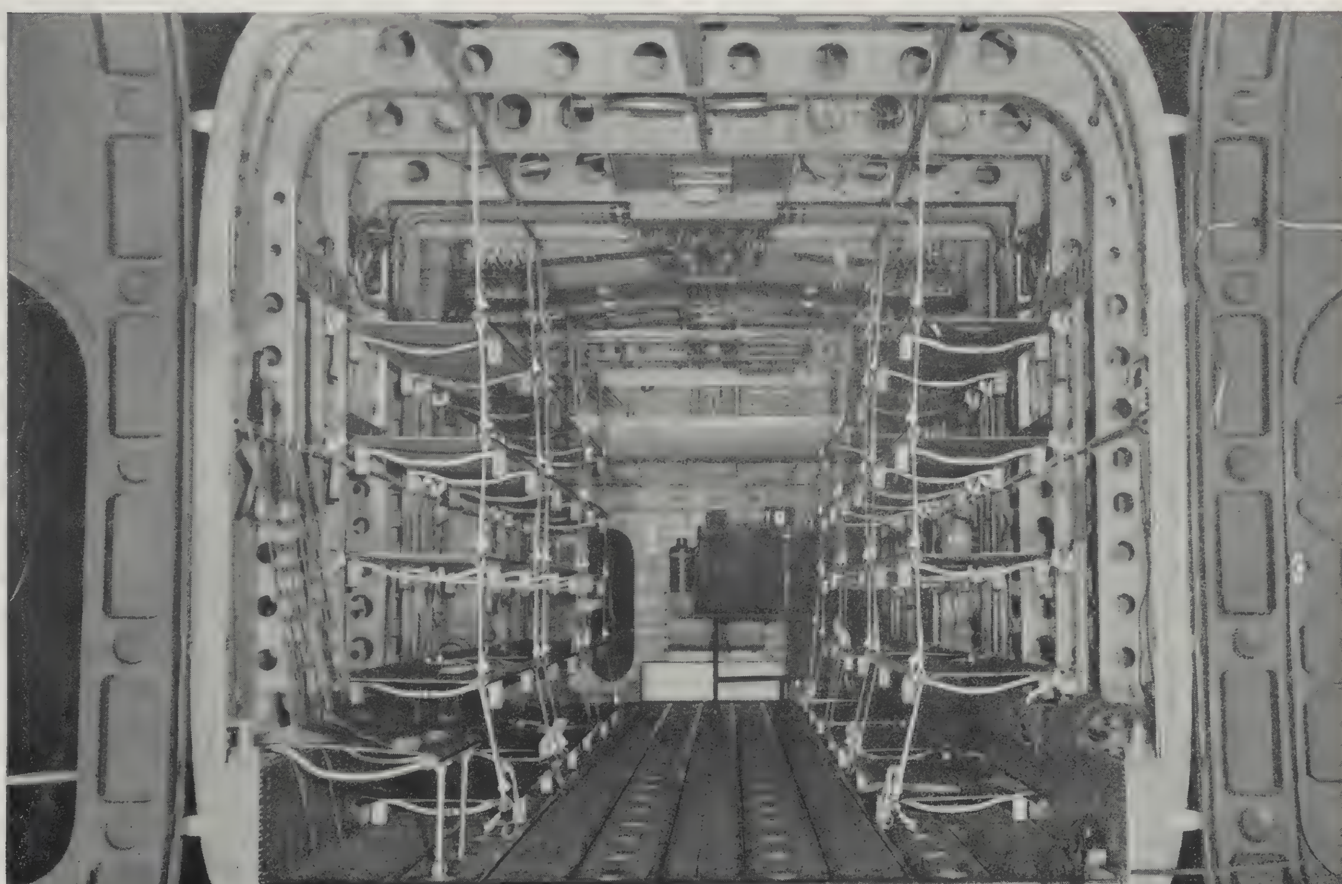
For details of patient-loading techniques see T.O.



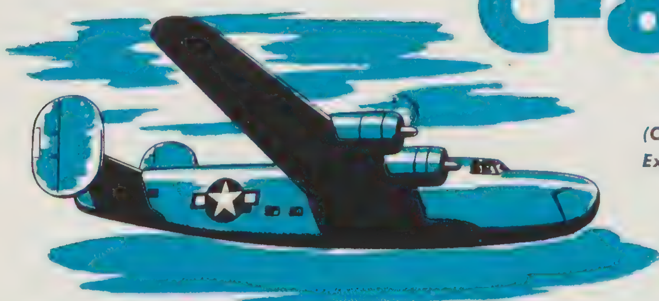
C-82


(Fairchild)

This distinctive twin-boom type aircraft has a maximum litter capacity of 34. Patients are loaded into the cargo compartment directly from the rear through the large freight door. Each tier of litter supports accommodates 5 litters except the right front tier which has provisions for only 4 litters. The top litter supports, which are more difficult to load, may be used for supporting a litter loaded with baggage when the additional patient capacity is not required. The aircraft is also equipped with standard Evans type troop benches.



C-87



(Consolidated-Vultee "Liberator Express")

This standard installation has a maximum litter capacity of 14. Because of the relative complexity of modification of C-87s for air evacuation this aircraft's use in air evacuation has been relatively limited.

CG-4A

(Waco)

The maximum litter patient capacity of this glider is 6. Six ambulatory patients may be transported at the same time. Although glider pick-ups with litter patients are not recommended except under emergency circumstances, this procedure has been successfully accomplished, using the standard litter installation.

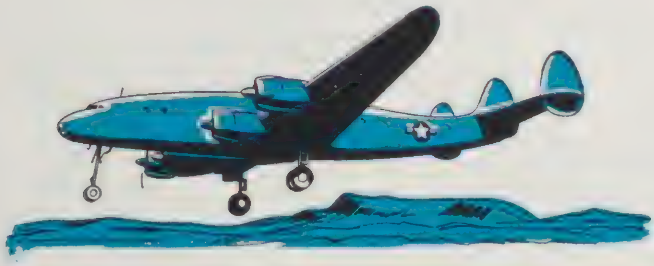
C MISCELLANEOUS LITTER INSTALLATIONS

METAL CRADLE TYPE LITTER SUPPORTS FOR THE C-47s

Although the great majority of C-47s are equipped with standard strap supports, a moderately large number have the metal cradle type litter supports which accommodate 18 patients per airplane. This type of installation is gradually being replaced because of its difficult stowage and assembly, smaller litter capacity, excessive weight, and the frequency with which its many loose parts are lost.

BUNK INSTALLATION FOR THE C-69

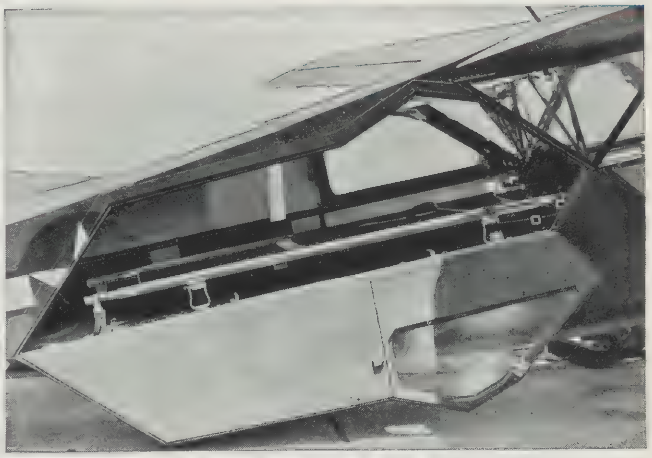
(Lockheed "Constellation")



This high-speed, pressurized-cabin, passenger transport is equipped with bunks for a maximum of 22 patients. In addition, it has seats for a maximum of 16 others. Although the C-69 is designed primarily for transporting of passengers and ambulatory patients, litter patients can be transported in limited numbers if necessary. The relatively small size of the passenger door makes loading of standard pole litters into the cabin difficult but not impossible.

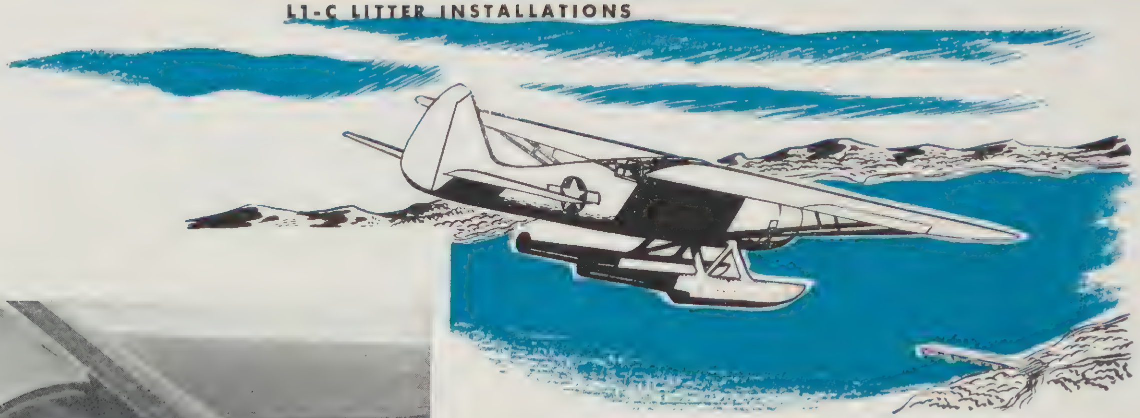
LITTER INSTALLATIONS FOR L-5 SERIES AIRCRAFT

All recent L-5 series aircraft have been of the L-5B model, with the rear part of the fuselage designed for transportation of a passenger, litter patient, or cargo. The L-5B accommodates patients on pole type litters, Stokes litters, and standard semi-rigid litters.



In order to make possible the transportation of litter patients in early L-5 models an approved modification which can be used under field conditions has been developed. Details of the modification and technique for loading litter patients into the modified aircraft can be found in T.O. 01-50DB-19. With this installation, standard semi-rigid litters (U.S. Medical Department Catalog Number 9936000) are used.

L1-C LITTER INSTALLATIONS

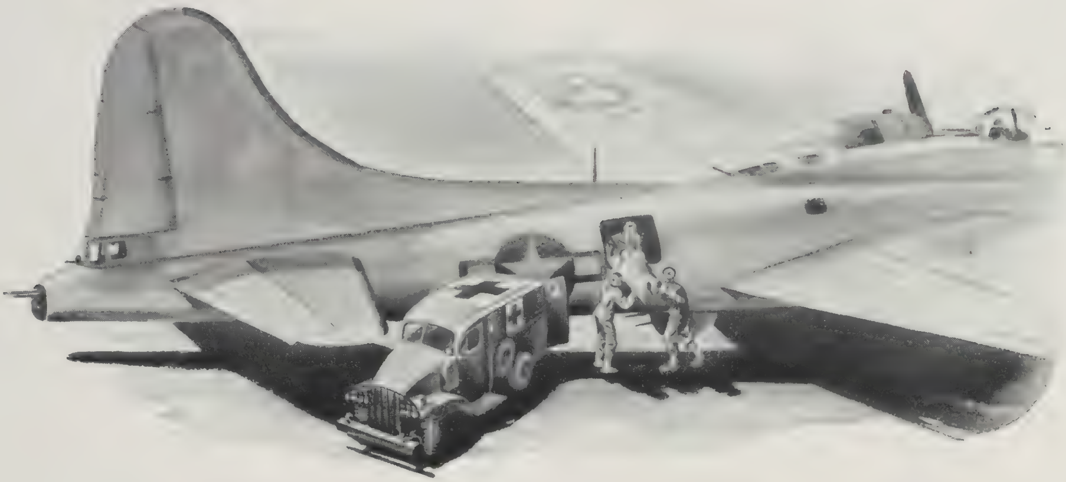


Because of its outstanding flight performance this aircraft, which is no longer in production, retains its usefulness, particularly in relation to rescue work in inaccessible places. The L-1C transports 1 litter patient and the pilot. Floats and skiis add to the usefulness of this aircraft in rescue work.

HELICOPTER LITTER INSTALLATIONS

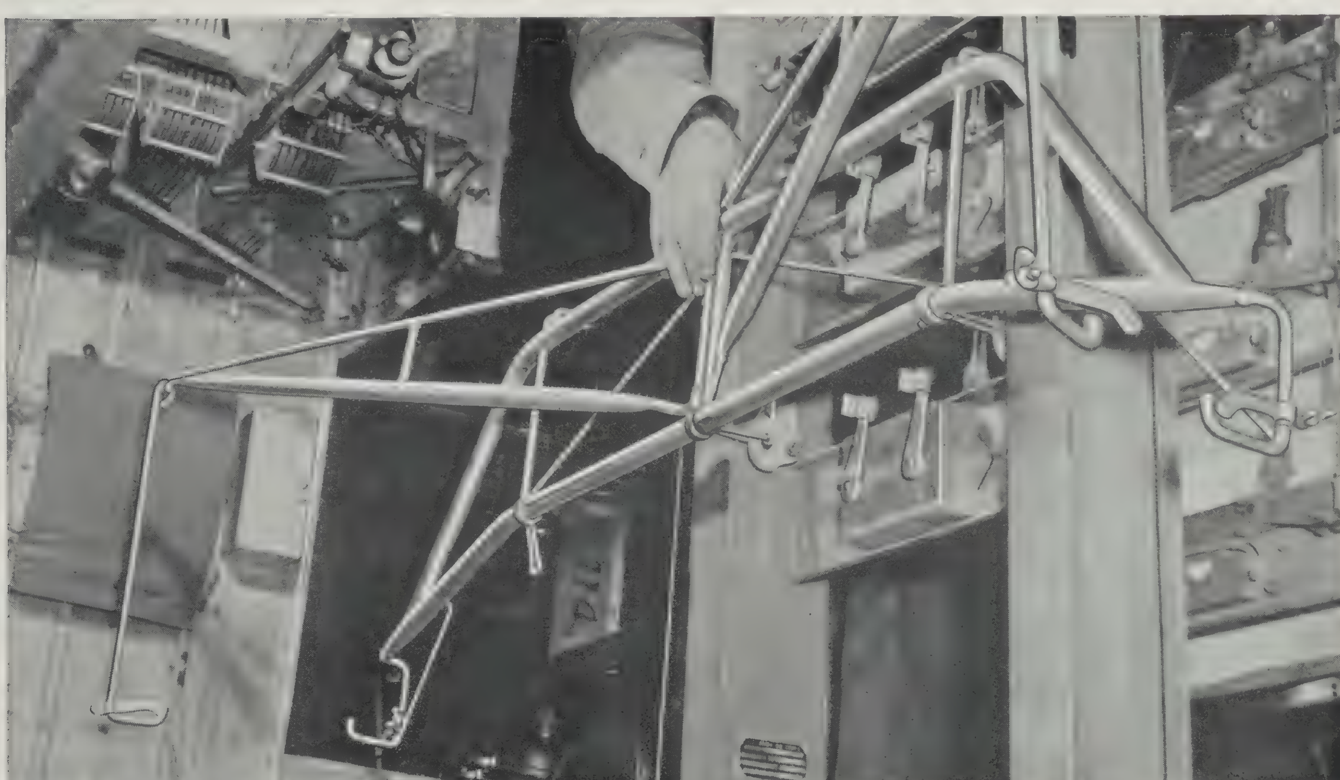
Until helicopters capable of transporting patients within the fuselage become available, all suitable AAF helicopters are being equipped with "litter capsules." Standard capsules with transparent ends are being procured for all R-6's (2 per helicopter) and R-5's (4 per aircraft), and will be kept at each helicopter base for immediate installation when required. Headphones and throat microphones, used in conjunction with a small temporarily-installed interphone set, make possible two-way communication between patients and crew in flight if this should be necessary.

STANDARD BOMB RACK LITTER SUPPORTS



When cargo aircraft equipped with litter supports are not available, litter patients may be transported in bombardment aircraft on standard bomb rack litter supports designed for use in any AAF heavy or medium bomber. The supports are quickly snapped into the bomb rack hooks which normally hold bomb shackles. One bomb rack litter support is required for each patient. Although variations in bomb bays in various models alter considerably the amount of available space for litters, the usual maximum bomb bay litter capacities with the standard supports are:

B-17—6 **B-26—4**
B-24—8 **B-25—2**



D IMPROVISED LITTER SUPPORT EQUIPMENT

There are times when, in an emergency, litter cases must be transported in the only aircraft available and with any means of litter support available. Under such conditions, the actual means for litter support will vary with the aircraft and the ingenuity of the responsible personnel.

Illustrated herewith are a few methods that have been used in the past under such conditions in the field. None of these installations have been thoroughly tested. The stresses involved are of unknown magnitude and the methods are not officially approved. They are given here as suggestions only to those who might be required to evacuate patients under emergency conditions.

Bombardment Aircraft:

On a number of occasions, patients have been moved in bombardment airplanes without the use of the standard bomb rack litter supports. It is not as desirable as the use of regular cargo aircraft, but one advantage is that the evacuation may be carried out under the protection of the plane's own firepower.

B-17. A patient is loaded into a B-17 through a side gunner's window. Even an improvised litter can be used successfully in this type of emergency evacuation by airplane. In the figure one patient has already been slung into place up forward, beyond the left side gunner's window. The snaps of the field harness are used to fasten the straps to the frame of plane. The straps are adjustable, making them very adaptable to this type of use. Three litters can be slung in place with harness from field packs. Three more litters may be placed in front of the bomb bay.

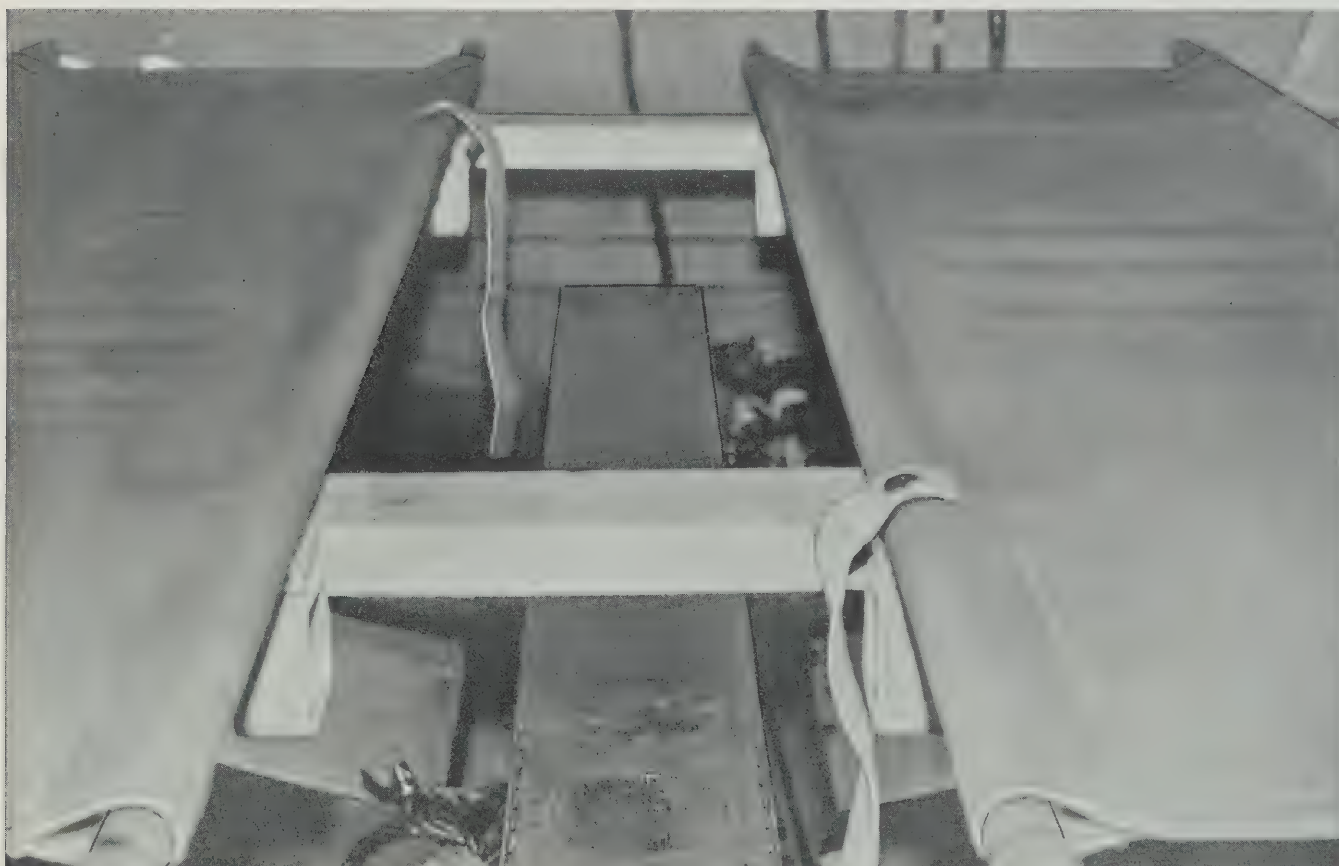
B-26. Method A. This installation permits the carrying of 8 litter patients with no changes in the plane and with very little equipment. A bar with metal fittings designed to fit over the bomb rack hooks is used. Two straps of parachute webbing approximately 6 ft. long are suspended from the bar. Small web loops are attached at approximately 16 inch intervals to accommodate the litter stirrups. With the bomb bay doors open, the top bomb shackle on each rack is replaced by the litter suspension bar described above. Two of these bars, 1 on each rack, will support a tier of 3 litters. The first litter is raised from the ground by 2 bearers and elevated high enough, using a step if necessary, to permit a third man standing on the bomb bay catwalk to slip the highest web loops over the litter stirrups. The middle litter and lower litter are loaded in like manner. The forward bomb bay will accordingly carry 3 litter patients on each side, making a total of 6. It is possible to carry 2 litter patients in the rear bomb bay by placing 2 x 4 wood members crosswise in the ship to support the litters.

Method B: When authorized bomb bay litter equipment is not available, bombing planes may be converted for the emergency evacuation of casualties by an improvisation which involves no structural changes in the aircraft and requires only readily available materials.

Litters are suspended from the bomb racks, each litter being supported by 4 adjustable straps previously clipped to the bomb shackles. As the loaded litters are lifted into position through the open bomb bay doors, 1 strap is slipped around each litter stirrup, providing 4 point suspension. Where space is limited (as in the rear bomb bays of the B-26) folding litters from which the wooden handles in the aluminum bars have been removed may be used. Adjustable straps are used; 3 and 6-foot lengths for hanging the litters; 1-foot lengths for securing the inner litter bar to the bomb rack uprights; 3 and 6-foot lengths, made of 2-inch strapping are equipped with a snap fastener to permit attachment to the bomb shackles. One-foot lengths are made from 1-inch strapping. Materials are available in any parachute department. Patients are accessible while in flight from the companionway through the bomb bays. In the B-26, each side of the forward bomb bay will accommodate 3 patients; each side of the rear bomb bay will accommodate 2. The disadvantage is the complexity of the strap equipment and the ease with which it becomes displaced.

Cargo Aircraft:

No litter support fittings are available in some of the older cargo aircraft, but litters may be placed in the plane and lashed to the cargo fittings as may be necessary.



REFERENCES

T.O. 00-75-1, Air evacuation technique of loading patients in C-47 and C-47A airplanes, 1 Jul 1944.

T.O. 00-75-2, Air evacuation technique of loading patients in C-46 airplanes, 30 Nov 1944.

T.O. 00-75-3, Air evacuation technique of loading patients in UC-64 airplanes, 5 Jan 1945.

T.O. 00-75-4, Air evacuation technique of loading patients in C-54 airplanes, 15 Jan 1945.

T.O. 01-50DB-19, Vultee-Installation and use of litter provisions-L-5.

Air Surgeon's Bulletin:

a. March 1944, UC-64 litter installation.
b. Apr 1944, Litter support installations for the C-47 airplane.
c. Jul 1944, C-54 litter supports.
d. Aug 1944, L-5B litter support installation.
e. Sep 1944, Helicopter in air evacuation.
f. Oct 1944, Litter support installations in C-87 aircraft.
g. Nov 1944, Litter support installation for C-46 airplanes.

AAF Reg. 25-17, Hospitalization and evacuation in the continental U. S., 6 Jan 1944.

AAF Ltr. 80-20, Telephone and transportation facilities for air evacuation personnel, 11 Jul 1944.

SECTION 5

RECORDS, REPORTS AND ADMINISTRATIVE PROCEDURES

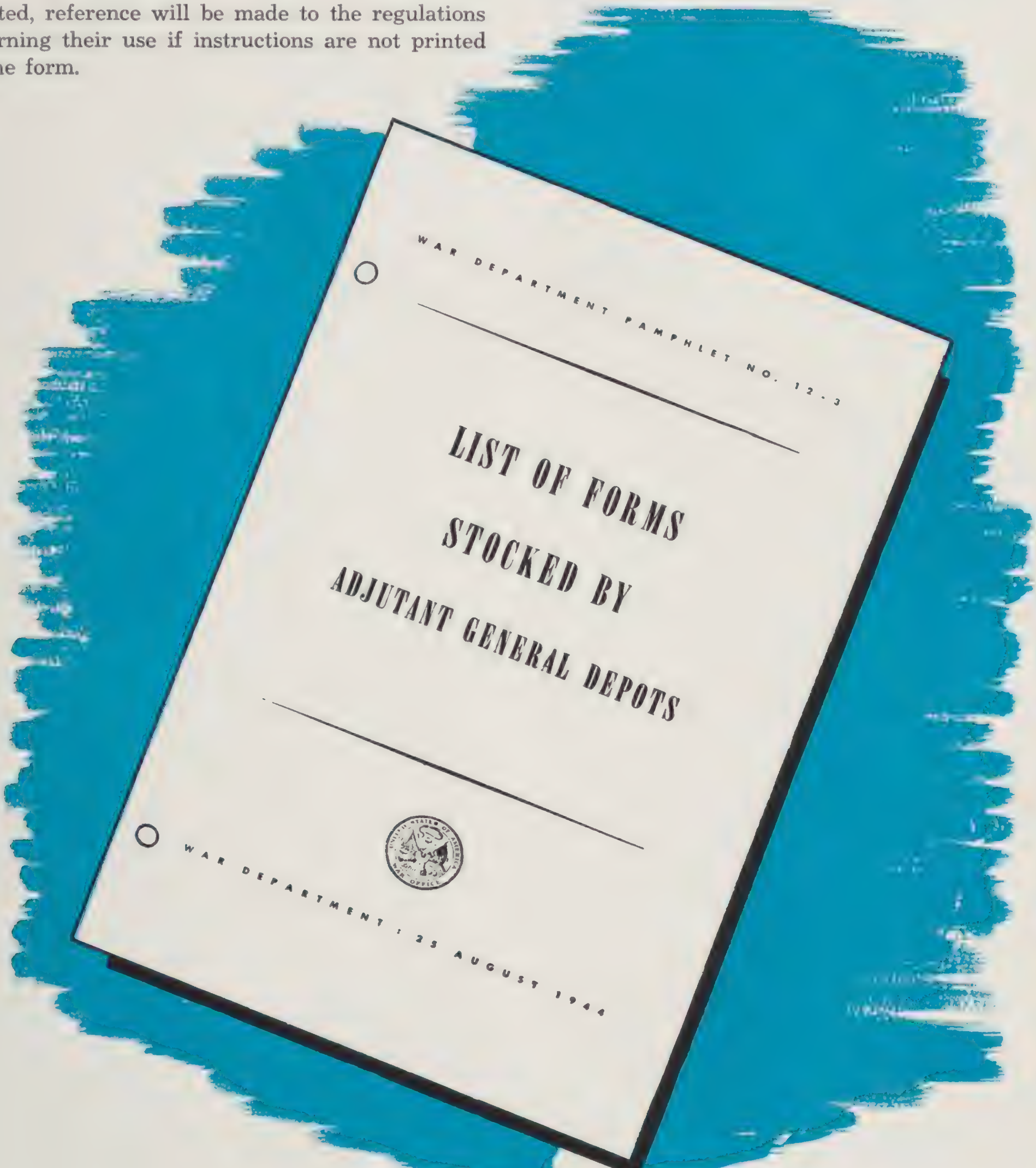
SECTION 5

RECORDS, REPORTS, ADMINISTRATIVE PROCEDURES

1. WD Forms Used.
2. Medical Records and Administration of Flying Personnel.
3. Rendition of Medical Reports.
4. Personnel Processing.

WD FORMS USED

A list of forms stocked by Adjutant General Depots may be found in WD Pamphlet 12-3, 24 March 1944. On new War Department and arm or service forms adopted, reference will be made to the regulations governing their use if instructions are not printed on the form.



REFERENCES

WD Pamphlet 12-3, List of forms stocked by Adjutant General Depots, 25 Aug 1944.

WD Circ 264, War Department publications and blank forms: procurement, distribution, requisitioning, storage and issue at all class 1, 2, and 4 installations, 28 June 1944.

MEDICAL RECORDS AND ADMINISTRATION OF FLYING PERSONNEL

Physical Examination for Flying (WD, AGO Form 64)

General instructions.

Fill in every entry. If a heading is not applicable use dashes.

The term "Normal" will be used wherever possible to indicate usual, average qualifying findings. Significant abnormalities are to be described in detail. If these are not symptomatic, indicate by the abbreviation "NS". If they are not disqualifying, indicate by the abbreviation "ND". If they are temporarily disqualifying, indicate by "TD"; if permanently disqualifying, indicate by "PD"; if considered disqualifying, indicate by "CD".

"Negative" will be used only to report the results of laboratory tests and x-rays.

"None" will be used when indicated. Example: "Varicose Veins–None."

If there is insufficient space under any item enter "see Par. 37", and continue remarks in that paragraph.

If additional sheets are required, they will be considered in an extension of Par. 37, and should be permanently attached, preferably by pasting, to the Form 64.

Instructions for special items.

Par. 1. Give full name, including middle name. If there is a middle initial only, give initial without a period. If there is no middle name or middle initial, put a dash after the first name. When "Jr." or a similar designation is used, it will appear after the middle name. The abbreviation "NMI" and "IO" will not be used. If no military status, write "Civilian" over "(Grade and arm or sevice)." "Grade" includes Pvt, Sgt, Avn C, 1st Lt, etc. "Arm" includes Air Corps, Artillery, Infantry, and other combat arms. Services are Medical Department (subdivision Medical Corps, Army Nurse Corps, etc., to be used in the case of officers), Quartermaster Corps, Finance Department, etc.

"Age" is computed to nearest birthday. "Years of service" are completed years of active service. If less than one year express as twelfths of a year.

Par. 2. If in service give complete service address including organization unit. The "Purpose of Examination" will vary a good deal. The following are authorized entries. Although listed singly, an examination may be for a dual purpose in which case both purposes should be indicated.

1. For applicants and trainees.

a. "Selection." The original "64" examination made to determine the eligibility of an individual to take training for duties as a member of the air combat crew. It includes the examination made on enlisted combat crew returnees, and on commissioned returnees who hold an aeronautical rating but desire training for another rating. (When done on original applicants by other than a flight surgeon or aviation medical examiner, this examination is accomplished on a WD AGO Form 63 or on a certificate.)

b. "Classification." The "64" examination made by the medical examining service of the AAF Basic Training Center (see Section 2-3).

c. "Rating and appointment (pilot, glider pilot, service pilot, liaison pilot, or type of aircraft observer depending on flying duty assigned)." The examination made at the completion of training just before an aeronautical rating is granted. The examination also serves as the official one required before the individual receives an appointment as a commissioned or flight officer.

d. "Rating (pilot, bombardier, etc)." If an officer or enlisted man has successfully completed training in grade, the purpose of the examination is to determine his eligibility for an aeronautical rating or simply "rating."

2. For rated personnel.

a. "Annual." The periodic examination made on all flying personnel, usually annually, but occasionally at other times by directive.

b. "Temporary suspension." Though not strictly a "purpose" of examination, actually this examination will not be made unless the flight surgeon already knows that the individual will be incapacitated for more than 30 days and less than 6 months.

c. "Indefinite suspension." Remarks for temporary suspension will apply except that the period of incapacity will be for more than 6 months.

d. "Removal of suspension." The examination accomplished at the time the sick or injured flyer is regarded as well enough to resume flying duties.

e. "Prior to flying evaluation." The examination performed at the request of a Flying Evaluation Board.

f. "Overseas assignment." The "64" examination

accomplished on rated personnel prior to overseas assignment.

g. "Return from overseas." The "64" examination accomplished on rated personnel returned from overseas duty. This examination is usually accomplished at a station of the Personnel Distribution Command.

3. Miscellaneous.

a. "Qualification for AAFSAM." The examination made on medical officers or nursing officers to determine physical eligibility for attendance at the AAF School of Aviation Medicine.

b. "Designation, Flight Surgeon," or "Designation, Flight Nurse." The examination performed as part of the request for designation as flight surgeon or flight nurse.

c. "Flying status." The examination to determine the eligibility of aviation medical examiners, flight surgeons, flight nurses, officers of other branches, and enlisted men applying for flying status.

d. "Foreign Student (pilot, etc)." The examination made on subjects of allied nations taking flying training.

e. "Active duty;" "Relief from active duty." When a flying officer in the regular army, reserve corps, national guard, or A.U.S. with an aeronautical rating is ordered from inactive to active duty, or reverse, these purposes will be used respectively.

Par. 4. In this paragraph should appear remarks concerning any of the conditions called for in small print. A comprehensive history of personal illnesses (childhood and adult), of familial illness relative to selection, and of personal surgery, injury, or abnormality will be recorded. No physical findings will be recorded here. Give dates (year), not age at which disease occurred. Limit wordage. Negative statements need not be made, with two exceptions: For amplifying a disease or injury, state "no complications" or "no sequelae" after it; in the event the examinee denies all medical history enter "denies any illness, injury, or operation."

Par. 5. After "Inspection" include notations on "Ocular Tension" and on results of the "Cover Test." Findings on the Cover Test will be noted as "Ortho," "Eso," "Exo," "R.H.," "L.H.;" if heterotropia is present, its type will be noted.

Par. 6. After "Pupils: Equality" enter "Equal" or "Unequal," or describe abnormalities.

Par. 7. Visual acuity will always be indicated in positive values, e.g. 20/20 + 6, not 20/15 — 2. The acuity notations 20/25 or 20/18 will not be used. If glasses are worn enter the prescription in par. 37.

Par. 8. "Heterophoria at 6 meters." If glasses are worn during the examination indicate that correction is worn by noting the abbreviation "Cor." in the extreme right margin, after "Prism divergence."

Par. 10. "Red lens test." If diplopia is found, list as crossed or uncrossed diplopia and the direction and distance from the neutral point at which it occurs, e.g., "Crossed diplopia, 25 cm., upper right meridian."

If suppression is found, note the eye suppressing and the direction and distance from the neutral point at which it occurs, e.g., "Suppression, left eye, 30 cm, upper vertical meridian." If glasses are worn during the examination enter the abbreviation "Cor" in the proper space.

"Angle of Convergence." Strike out the letter "B" in "PcB" and record the point of convergence in the space "Pc". If glasses are worn during the examination, enter the abbreviation "Cor" in the space "...........°."

Par. 11. "Accommodation." The accommodative power need not be recorded in the case of individuals being examined specifically for qualification in Classes II or III. If the accommodative power is less than 2 diopters, enter the notation "Unable" in the spaces provided.

"Addition required for 50 cm." No entry is required. "(Jaeger type)." Near visual acuity, determined at an examining distance of 50 cm, is noted as "J-1-50," "J-6-50," etc. "J-6-50" indicates that J-6 type is legible at a distance of 50 cm. If glasses are worn, and if the reading correction differs from the distance correction, the prescription for the reading correction will be entered in paragraph 37.

Par. 12. "Color Vision." Proficiency will be indicated as follows:

If the examinee makes 4 or more misinterpretations in the American Optical Co's 19-plate abridged edition, enter the notation "Fails A.O. abridged."

When the AAFSAM Color Threshold Tester is employed adjunctively the score attained thereon is indicated. If, on the basis of the score, the examinee is considered unsafe for flying duties, that fact is also noted, e.g., "AAFSAM CTT 54, Safe."

Par. 15. Use "Denies," if no history of ear trouble is admitted. If history of ear disease is admitted, record the diagnosis, the ear involved, date of occurrence, operative procedure, if any, and sequelae, if any.

Par. 17. Hearing loss by the audiometer test will not be recorded in percentages, but will be recorded as average decibel loss computed from the practical conversational range of hearing.

Par. 18. Deviations of the septum will be recorded

in terms of obstruction. For example: "Septum deviated to right; 40% obstruction, NSND," or "Septal spur on left interfering with ventilation and/or drainage of the middle meatus, TD."
Tonsils: "Enucleated," if they have been removed. Do not describe the tonsils unless they have, or may have in the future, some pathological significance. Do not use the term "present." Record "normal," if such is the case.

Par. 19. Remarks including other defects—State "no teeth missing" if this the case. Enter gingivitis, stomatitis, etc., if present. Also enter irregularities which may be of value in identification, e.g. "tooth malposed R 13 lingually." Note type of malocclusion if present.

Par. 20. Use "Denies," if no history admitted.

Par. 23. Record height to nearest ¼ inch, weight to nearest pound, chest measurements to nearest ¼ inch.

Par. 27. "Exercise Test" is the standard test of hopping on one foot 100 times.

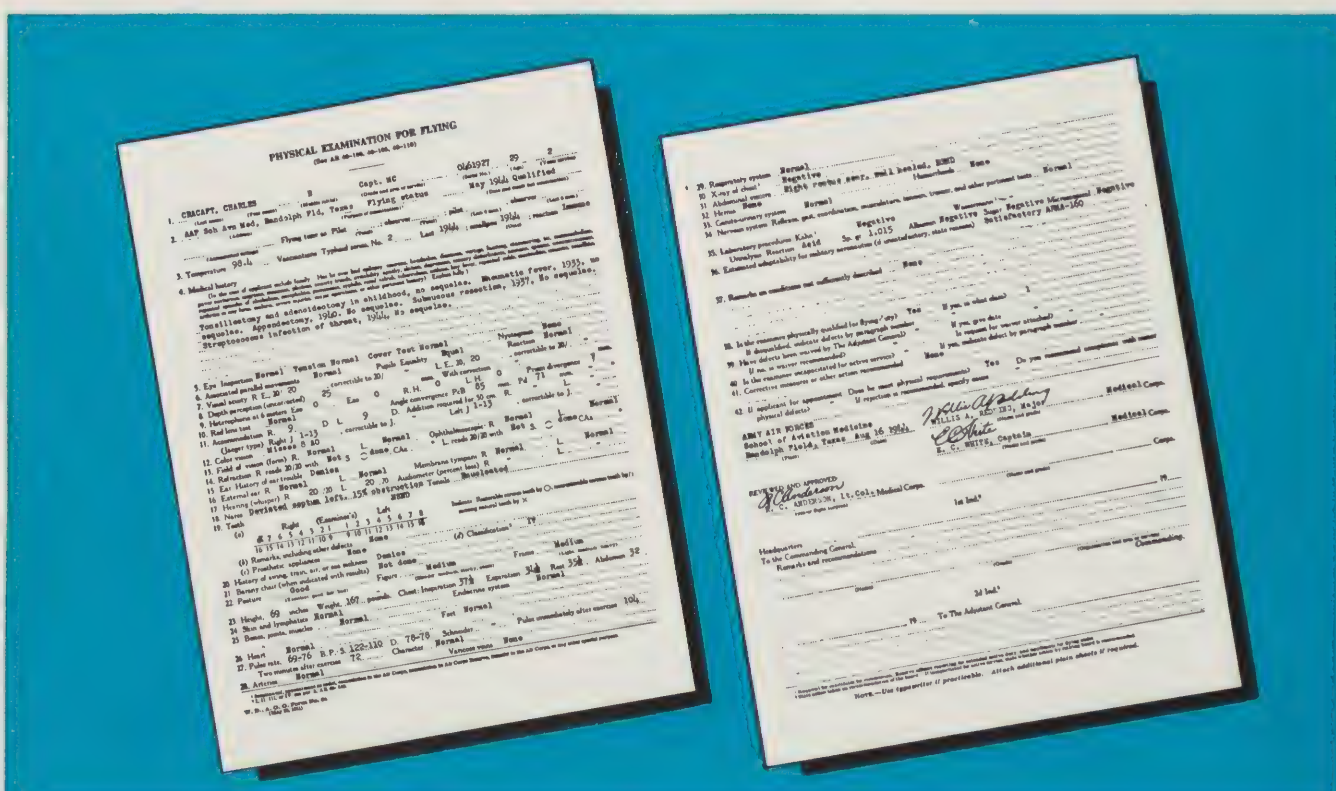
Par. 30. Use "Negative." If x-ray report contains any findings other than normal or negative data, include the entire x-ray report verbatim.

Par. 35. If Kahn is negative and Wassermann test not made put dashes after "Wassermann." Microscopical to be completed on all original and on final type examinations; otherwise put dashes after "Microscopical."

Par. 36. State either "Satisfactory" or "Unsatisfactory." Follow this by "ARMA," giving the score. The reasons for the unsatisfactory "ARMA" are to be entered in par. 42 where such general terms as "emotional instability," "inadequate achievement," "immature personality development," etc., are to be used.
Do not put in paragraph 36 any remarks which rightly belong in paragraph 4.

Par. 37. Begin continuation as: "Par. 18, cont'd." Continuations should follow each other in their numerical sequence. If there are no remarks, state: "none." Reasons for waiver of minor defects should be placed in this paragraph. When an entry on night vision is required (AAF Reg. 25-2), the following information must be stated: The instrument employed, a word description of performance, and the specific score attained. Abbreviations may be used as follows:

AAF-Eastman Night Vision Tester EK
Superior Sup
Hecht-Schlaer Adaptometer HS
Satisfactory Sat
SAM Portable Night Vision Tester SM
Unsatisfactory Unsat



Example: "Night Vision: EK–Sat–28"

Par. 38. "Qualified?" Yes or No. "Class?" 1, 2, or 3 (if qualified). If disqualified put in a dash. If disqualified but waiver recommended, indicate as follows: "1 (or 2 or 3) if waiver is granted." List disqualifications by paragraph number only as 7, 10, 18, 36. Do not enumerate the actual disqualifications.

Par. 39. Dash out on original applicant. Fill in as indicated on other examinations.

Par. 40. Dash out on original applicant. Fill in as indicated on other examinations.

Par. 41. Use "none" or one of the following remarks: (a) "Disqualified, reexamination not recommended." (b) "Disqualified, reexamination recommended." For original applicants, do not include any recommendations for correction of temporary defects. (c) If the applicant is to wear glasses while flying, a statement to that effect will appear in this paragraph. (d) other remarks as indicated, including recommendations for waiver of minor defects.

Par. 42. On original examinations only, does he meet physical requirements? "Yes" or "No." Do you recommend acceptance with minor physical defects? "Yes" or "No." If rejected enumerate disqualifications, for example: "Defective color vision, hypertension, inadequate achievement."

Signatures. Two on the right, and one reviewing officer. Flight surgeons and aviation medical examiners may sign the "64." Typewritten name will appear below the officer's signature.

Air crew member physical record card (WD AAF Form 206)

A typewriter should be used to accomplish this form if possible. Spaces are provided for the individual's name; army serial number, which should be recorded directly following the name; and aeronautical rating held. Where no aeronautical rating is held, enter designation; e.g., "Flight Surgeon," "Radio Operator," etc.

Eight spaces are allotted to *Examinations for Flying.* Properly used these spaces can furnish a concise, consecutive account of the physical status of flying personnel over a considerable period of time. Annual examinations should be recorded in all instances as should all examinations which effect a change in the individual's flying status, except "check-up" examinations which show no significant differences from the preceding examination.

Date—will be written in the approved abbreviated form: e.g., 24Jun44, 12Dec44, etc., without spacing or punctuation.

Station—should be abbreviated but not to such an extent as to be unintelligible; e.g., Mitchel Field, New York—"Mitchel Fld, NY;" Laredo Army Air Field, Texas—"LAAF, Tex;" "AAF Sta 126;" etc.

Result—Use "Q" for qualified, "D" for disqualified.

Defects—only disqualifying defects should be noted. If none exists record "None." Abbreviations authorized in AR 850-150 may be used in addition to those authorized by FM 8-45 on Emergency Medical Tags and Field Medical Records. In addition, it will often be necessary to use unauthorized abbreviations in order to convey necessary information. In this regard, abbreviations which are generally understood among medical officers may be employed. Abbreviation to the point of unintelligibility is obviously useless and should not be used. The object is to convey as clearly and definitely as possible the disqualifying defect without using more than one space. If more than one disqualifying defect exists and it is not possible to convey both or all, record the most outstanding defect.

Waiver—this refers to disqualifying defects that have been waived and requires only an entry of "yes" or "no."

Personnel Orders—when personnel orders are issued affecting an individual's flying status as a result of a physical examination, the number, issuing headquarters and date of such orders should be recorded.

Flight Surgeon's Initials—each examination must be authenticated by the written initials of the examining flight surgeon. These initials must be recorded legibly so that with station and date they can be used as a check.

The spaces provided for Foreign Service are in the main self-explanatory and require but brief comment.

Theater—abbreviate; e.g., "ETO," "MTO," "FE," etc.

Date Entry and Date Departure—Refers to date of entry into theater and date of departure from theater. This date should be recorded as described above.

Hours Flying—Refers to total hours of flying accomplished by the individual concerned while in theater and will serve to convey an indication of the individual's accomplishment while on foreign service.

Illness or Injury—Record here only major, debilitating illnesses or injuries. Minor or non-incapacitating illnesses or injuries, even though they may have been the cause for occasional grounding, should not be recorded unless residuals exist which might reasonably be expected to affect flying proficiency.

Flying Status—this refers to flying status on de-

parture from the theater and should be recorded as "Suspended" or "Flying" as the case may be.

The spaces provided after *Restricted* are intended to contain data which will let the flight surgeon know of any restrictions, as a result of a medical defect, which limit the individual's flying duties.

Date—Recorded as described above.

Restriction—record here what restrictions on the individual's flying exist. The causes for such restriction need not be mentioned as they will ordinarily be apparent and noted under the Defects column of the physical examination section; e.g., "Copilot only," "Limited to cont US," "tech obs only," "Command pilot only," etc.

Headquarters—record here the headquarters which issued the personnel orders restricting flying duties.

Date Removed—record here opposite restriction the date such restriction was removed.

Altitude Indoctrination—it is the responsibility of the Director of Altitude Training to accomplish the entries under this section.

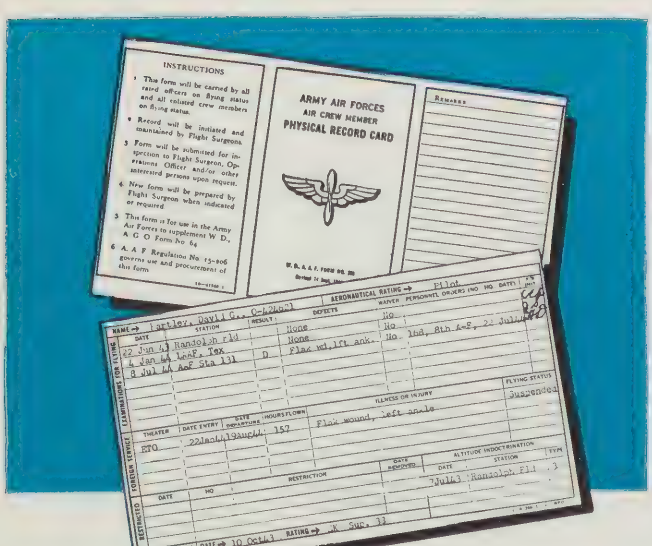
Date—to be entered as described above.

Station—To be entered as described above.

Type—to be recorded as Type 1, 2, or 3.

Night Vision—record here the date of testing and result of rating: "Superior," "Satisfactory," or "Unsatisfactory."

A certain number of individuals will be suspended from flying status because of severe psychosomatic symptoms or nervous tension associated with other manifestations which preclude the utilization of that individual in a flying capacity. The term, "anxiety reaction," will be used to designate this condition. The incapacitating condition may or may not have been due to the flying duties required. This judgment must be made by suitable medical authority. When the condition is not the direct result of undue flying stress, i.e., not the result of "harrowing experience," it will be entered in the "Defects" column as merely "anxiety reaction." When, however, an individual has been exposed to flying stress beyond that normally experienced in his present situation and such exposure has resulted in incapacity as described above, the incapacity will be judged to have been the result of an "aviation accident." The incapacitating condition in this situation will be recorded in the "Defects" column as "anxiety reaction, aa."



REFERENCES

AAF Reg. 15-206, Blank forms, air crew member physical record card, AAF form 206, 17 Oct 1944.

AR 850-150, Authorized abbreviations and symbols, 18 Sept 1944.

FM 8-45, Records of morbidity and mortality (sick and wounded), 1 Oct 1940.

Dental identification record (WD AGO Form 8-116)

The Dental Identification Record will be filled out on all flying personnel by a dental officer. It is retained by the dental officer until the flyer is transferred to a new station. It is sent with the Flight Surgeon's Record ("64" file) to the senior flight surgeon of the new station who in turn sends it to the dental officer. The Dental Identification Record of enlisted men on flying status is handled in a similar manner but on transfer of the man it accompanies the Service Record (WD AGO Form 24).

Suspension From and Restoration to Flying Status

Suspension from flying status may be of three different types—grounding, temporary suspension, and indefinite suspension—depending principally upon the anticipated duration of the disease or injury for which suspension was necessary. The various types of suspension, the authority for certification of physical examination records, the authority for suspending or removing suspension, and the authority for confirming the suspension or removal of suspension are listed in the accompanying chart.

Aviation Accident. An individual will not be suspended from flying duty when physical incapacity

FLOW CHART FOR SUSPENSION FROM AND RESTORATION TO FLYING STATUS OF A.A.F. RATED PERSONNEL (SEE AR 40-110; AR 35-1480 A.A.F. REG. 35-16)

DURATION	Grounding and Revocation Thereof	Temporary Suspension and Revocation Thereof	Indefinite Suspension and Revocation Thereof
	30 Days or Less **A**	Less Than Six Months **B**	More Than Six Months **C**
PHYSICAL EXAMINATION RECORD OR CERTIFICATE	Certificate by flight surgeon or A.M.E. of unit or station. RECOMMENDS grounding or revocation of grounding to C.O. Purpose of certificate: "Grounding" or "Revocation of Grounding."	W.D. A.G.O. Form 64 (triplicate) a certificate in lieu of 64 when exam is impracticable (only when recommending suspension). 64 required when recommending revocation of suspension. Purpose of examination: "Temporary Suspension" or "Revocation of Temporary Suspension."	W.D. A.G.O. Form 64 (triplicate) a certificate in lieu of 64 as in column B may be submitted when recommending indefinite suspension. Purpose of examination: "Indefinite Suspension" or "Revocation of Indefinite Suspension."
AUTHORITY TO CERTIFY PHYSICAL EXAMINATION RECORD OR CERTIFICATE	Fight surgeon or A.M.E. of unit or station certifies L.O.D. States cause of incapacity (result of aviation accident or not) and nature of disability. Certificate to C.O., copy for F.S. record.	The Surgeon of an air force or major A.A.F. independent Command 64 REVIEWED and CERTIFIED. Distribution of 64: Original: returned to unit or station. Copy . .: to air force or command file. Copy . .: Hdq. A.A.F.; Att: The Air Surgeon.	THE AIR SURGEON, hdq. A.A.F. 64 REVIEWED and CERTIFIED. Distribution of 64: Original and one copy: to unit or station thru command or Air Force concerned. One copy..........: A.A.F. 201 file.
AUTHORITY TO SUSPEND AND REVOKE SUSPENSION	Commanding officer of individual concerned. If verbal orders issued must be confirmed by written orders.	Commanding officer of individual concerned. Written order issued. Immediately reported to commanding general of air force or major A.A.F. independent command for CONFIRMATION.	Commanding officer of individual. Written order issued. REVOCATION of suspension by Commanding General Army Air Forces only.
AUTHORITY TO CONFIRM SUSPENSION AND REVOCATION OF SUSPENSION	Commanding officer of individual concerned. Written order confirms grounding. If individual remains grounded for period in EXCESS OF 30 DAYS it is immediately reported for review and confirmation of TEMPORARY SUSPENSION to the Commanding General of the Air Force or major A.A.F. independent Command concerned.	C.G. of Air Force or major A.A.F. independent command. Issues appropriate order confirming temporary suspension or revocation thereof. Radiographic order may be issued CONFIRMING REVOCATION of suspension. Order will NOT indicate number of weeks or months of suspension. If temporary suspension exceeds 6 months, it automatically becomes an indefinite suspension and will be reported to the Commanding General Army Air Forces for review and confirmation. Temporary suspension and revocation thereof in the case of rated GENERAL OFFICERS on flying status and of other rated personnel not under the jurisdiction of an Air Force or A.A.F. independent command is confirmed by Commanding General Army Air Forces, headquarters Army Air Forces.	C.G. A.A.F., Hdq. A.A.F. written order issued confirming suspension or revocation of suspension. Radiographic order may be issued confirming REVOCATION of suspension. Rated personnel indefinitely suspended (more than 6 months) and who have been recommended for revocation of suspension and have been certified as physically qualified by the Air Surgeon, are required to appear before a flying evaluation board before revocation of suspension is confirmed by Commanding General Army Air Forces. Indefinite suspension and revocation thereof in the case of GENERAL OFFICERS or of other rated personnel who are not under the jurisdiction of an air force or A.A.F. independent command is confirmed by Commanding General Army Air Forces.

has occurred as a result of an aviation accident until he has remained on flying status for a period of 3 months during which time he is excused from meeting flight requirements. The flight surgeon must issue a certificate to the flyer because the flyer cannot certify his own flight certificate while excused from meeting flight requirements as a result of an aviation accident. If he is still incapacitated at the end of 3 months, he will be indefinitely suspended from flying duties and such action will be reported to the Commanding General AAF, for confirmation.

Forms. Whenever a flyer is suspended from or reinstated to flying status for medical reasons, the flight surgeon must inform the unit commanding officer in writing. Suggested forms for accomplishing this are shown.

CHANGE OF PHYSICAL QUALIFICATION AFFECTING FLYING STATUS

(Station) (Date)

1. Subject: Recommendation for Suspension or Excusal.

(Last name) (First name) (Middle initial) (Grade) (ASN) (Rating or Designation) (Age)

2. To: Commanding Officer

3. *( ) Subject individual having been found physically disqualified for flying duty under the provisions of AR 40-110 (not as result of aviation accident), it is recommended that he be suspended by written order effective the date found incapacitated in accordance with the provisions of AAF Regulation 35-16.

*( ) Subject individual having been found physically disqualified for flying duty under the provisions of AR 40-110 by reason of an incapacity resulting from an aviation accident, it is recommended that he be excused from meeting the prescribed flight requirements for a period not to exceed three (3) months, unless earlier found physically qualified. At the expiration of this time, if the individual remains incapacitated for flying duty, recommendations will be made from this office that he be suspended in accordance with the provisions of AAF Regulation 35-16.

*( ) Subject individual previously having been found physically disqualified for flying duty under the provisions of AR 40-110 by reason of an incapacity resulting from an aviation accident, having been excused from meeting the prescribed flight requirements for a period of three (3) months, and now remaining physically disqualified for flying duty, it is recommended that he be suspended in accordance with the provisions of AAF Regulation 35-16.

4. Estimated duration of incapacity from this date:

5. Date found incapacitated:

6. Diagnosis:

7. Flight requirements last met in month of:

8. Line of Duty: ( ) Yes; ( ) No

9. W.D., A.G.O. Form No. 64 attached: ( ) Yes; ( ) No

10. Total Hours Flown:
Hours in last 6 mos.:

11. Remarks:

12. Signature

13. Address

*Check appropriate entry.

REFERENCES

AAF Letter 25-8, Altitude limitations of flying personnel, 23 May 1944.

AR 40-110, The standards of physical examination for flying, 3 Dec. 1944.

AR 35-1480, Aviation pay: Officers, army nurses, warrant officers, and enlisted men, 10 Oct 1942.

AR 35-1360, Pay accounts of commissioned officers and others who certify their own pay and allowance accounts, 11 Apr 1944.

AAF Reg. 35-16, Flying status, Suspension and removal of suspension from flying, restriction on flying, and evaluation of flying personnel, 20 Oct 1944.

AAF Reg. 35-29, Flying status of enlisted men, 20 July 1942.

AAF Letter 35-144, Assignment procedures as determined by physical processing (of returnees) at redistribution stations of the AAF Personnel Distribution Command, 26 Sept 1944.

AR 210-10, Posts, camps and stations: administration, 20 Dec 1940.

WD Bulletin 35, Executive order 9195, regulations relating to aerial flights by personnel of the Army, Navy, Marine Corps, Coast Guard and National Guard, 16 Jul 1942.

CHANGE OF PHYSICAL QUALIFICATION AFFECTING FLYING STATUS

(Station) (Date)

1. Subject: Recommendation for Removal of Suspension or Excusal.

(Last name) (First name) (Middle initial) (Grade) (ASN) (Rating or Designation) (Age)

2. To: Commanding Officer

3. *( ) Subject individual presently suspended from flying, now having been found physically qualified for flying under the provisions of AR 40-110, it is recommended that the suspension be removed (revoked or rescinded) by proper authority and by written order in accordance with the provisions of AAF Regulation 35-16.

*( ) Subject individual, presently excused from flying duty by reason of an incapacity resulting from an aviation accident, is now physically qualified for flying duty in accordance with the provisions of AR 40-110. It is recommended that he be returned to duties involving flying.

4. Reason for suspension or excusal:

Line of Duty: ( ) Yes; ( ) No

5. Suspended by: Paragraph No. Order No. Date Headquarters

6. Suspension confirmed by: Paragraph No. Order No. Date Headquarters

7. Date found physically qualified for flying:

8. W.D., A.G.O. Form No. 64 attached: ( ) Yes; ( ) No

9. Remarks:

10. Signature

11. Address

*Check appropriate entry.

Care of flyer report (WD AAF Form 203)

Purpose. The Care of Flyer Report is designated to provide medical statistics concerning AAF military personnel who currently are under orders to participate in frequent and regular aerial flight.

Responsibility for Accomplishment. The senior flight surgeon of an AAF station or tactical unit is responsible for the accomplishment of the Care of Flyer Report. When several tactical organizations of the same command are situated at a single geographic location, the Care of Flyer Report of the various tactical units may be accumulated as a single Care of Flyer Report accomplished by the senior flight surgeon of the organization. In the presence of units of more than one major command at an AAF station, individual Care of Flyer Reports will be made out for each major AAF command represented. When individual units of a tactical organization are situated at different geographic locations, the Care of Flyer Report will not be accumulated from the several units, but each will be reported from its respective location, unless the units are part of an overseas organization.

In units operating outside the limits of the continental U. S. it is desirable, where practicable, to consolidate all reports for an overseas air force on a monthly basis as a single report of the major air force concerned. In accumulating monthly reports, certain months will be necessarily reported for periods of 4 weeks, while other months will be reported for periods of 5 weeks.

A report will not be submitted for units or organizations containing no flying personnel.

It is the intention that all Care of Flyer Reports, when finally accumulated as total statistics for the AAF, will represent total flying personnel of the AAF. It is therefore, important that there be no reduplication of reporting of individual units.

Period of the Report. The report will cover a period of one week, ending at 2400 Friday and will be forwarded not later than 1200 Tuesday of the week following the period of the report.

Distribution of the Report.

1. Continental U. S. The original copy of the Care of Flyer Report will be forwarded directly to the Commanding General, Hq., AAF., Washington, D. C., Attention: The Air Surgeon. A duplicate copy will be forwarded through channels to the commanding general of the major AAF command concerned, attention of the surgeon. A third copy will be retained by the reporting flight surgeon.

2. Overseas Theaters. An original and duplicate copy of the Care of Flyer Report will be forwarded to the commanding general of the air force or major independently operating unit concerned. A triplicate copy will be retained by the reporting flight surgeon.

Procedure of Accomplishing Report.

1. Organization. When the report includes the complete flying personnel of a single unit, e.g., numbered base unit, squadron, group, wing, etc., the designation of the unit will be entered, and the designation of the major AAF command. In the event that the report does not include all flying personnel of a unit or organization, only those complete sub-units reported will be listed with the major command concerned. When the report is of such extent that a considerable number of such units are reported, a separate list of organizations reported will be securely attached to the Care of Flyer Report.

2. Location. In designating location, the AAF station and post office address of the organization will be given. In preparing consolidated reports of overseas air forces, representing complete flying personnel of the organization, the designation of location will be the address of the headquarters of the organization. When, in the interest of security, it is necessary that geographic location not be stated, Army Post Office numbers must be entered instead.

3. Mean Strength of Flying Personnel. The figure for mean strength will include all AAF military flying personnel carried on the unit or organization morning report as assigned to the organization. Flying personnel admitted or treated as casuals from commands will be recorded on the report of the unit to which the personnel are assigned. Personnel temporarily or indefinitely suspended from flying status will be included as flying personnel in the Care of Flyer Report up to a period of 90 days from the date of their suspension from flying duty, unless dropped from the morning report of the organization in that interval. An individual dropped from the morning report will immediately be dropped from accounting in the Care of Flyer Report.

4. Number of Individuals Removed from Flying this Week. In this space will be listed the individuals on flying status who, as a result of a disability, have been suspended from flying duty for a period of twenty-four (24) hours or more during the period of the report. It will not include individuals suspended from flying who are remaining from a previous report.

5. Total Days Lost from Active Duty During the Week. Entries in this space will include the total days lost for all individuals suspended from flying, whether remaining from a previous report or originally entered on the current report.

6. Deaths, Flying Personnel During Week, All Causes. The number of deaths of flying personnel assigned to the organization from all causes, including those resulting from aircraft accidents, will be recorded here.

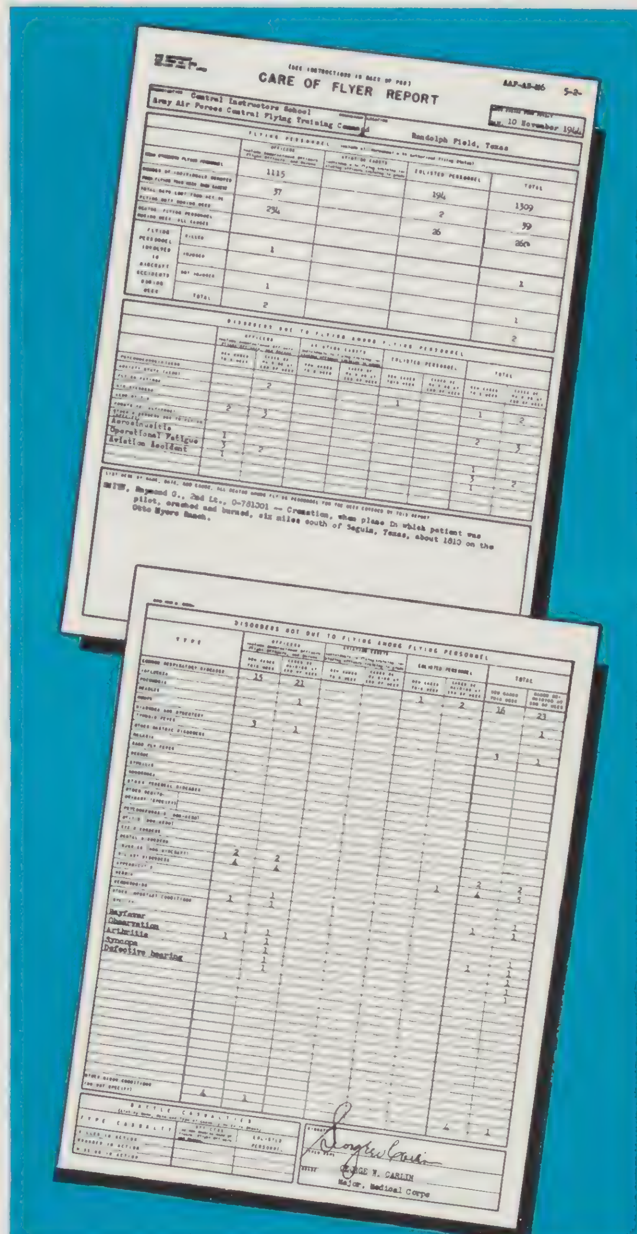
7. Flying Personnel Involved in Aircraft Accidents. Entries in this space will include flying personnel involved in an aircraft accident and will be carried on the report of the unit to which the personnel are assigned. The names, army serial numbers, and injuries sustained, if any, will be given for such personnel in the space at the bottom of the form. When flying personnel are killed or injured in aircraft accidents away from their home station, a notation will be made on the AAF Form 203 of the admitting unit, listing the names, serial numbers, and home stations of the individuals concerned. Statistics concerning such individuals will not be included in the columns of the Care of Flyer Report, reporting numbers of individuals involved in aircraft accidents.

8. Disorders Due to Flying Among Flying Personnel. The number of flying personnel removed from flying duty during the period of the report by reason of a medical disability resulting primarily from their flying activities is recorded in this section. Numbers are recorded for specific diagnoses. Diagnoses not included in the printed list on the form will be specified in writing in the space provided. "New Cases This Week" refers to individuals who have been removed from flying duty during the period covered by the report. "Cases Remaining At End of Week" refers to individuals remaining suspended from flying duty at the end of the week covered by the report.

9. Disorders Not Due to Flying Among Flying Personnel. In these spaces are recorded the number of flying personnel removed from flying duty during the week as a result of a disability not attributable primarily to flying activities. Important diagnoses not included in the printed list will be specified in the space provided.

10. Battle Casualties. Enumerate specifically for officer and enlisted personnel the battle casualties, killed, wounded, injured and missing in action among flying personnel for theaters of operations. A supplementary list will carry all battle casualties by name, army serial number, date, and type of casualty.

General. When flying personnel are admitted to an AAF hospital as casuals from commands, it will be the responsibility of the senior flight surgeon of the hospital to notify the commanding officer of the station of assignment of the individual admitted. The commanding officer of the station of assignment will be informed of the fact of admission, diagnosis, and anticipated period of hospitalization.



REFERENCES

AFTAS Ltr., Instruction for accomplishing care of flyer report, AAF Form 2.3, Revised, 1 Oct 1943.

AFTAS Ltr., Accomplishment of care of flyer report, AAF Form 203, 8 Apr 1944.

MEDICAL OFFICER'S REPORT OF AIRPLANE ACCIDENT

WD AAF Form 205 (Revised 15 May 1944)

Aircraft accidents are investigated by medical officers to provide specific information concerning all injuries sustained by personnel and to determine how these injuries are produced. In addition, it is important to ascertain, in some accidents, why no injuries have resulted.

All major accidents will be investigated by an Aircraft Accident Investigating Board (see Section 3-8). A *major accident* is defined (AAF Reg. 62-14) as one which results in major injury or death to persons or major or more extensive damage to the aircraft. A major injury with respect to aircraft accidents is defined as follows:

1. Will probably require hospitalization and medical treatment for a period of 5 days, or
2. Results in any of the following: unconsciousness; fracture of any bone (except simple fracture of fingers or toes); lacerations which involve muscles or cause severe hemorrhages; lesions of any internal organ; burns involving more than 5% of the body surface, or burns involving less than 5% of the body surface if they be to the second or third degree.

A minor accident is one which results in injury other than above to persons or results in minor damage to the aircraft. It is investigated by the station accident officer. Medical officers are therefore not required to investigate minor accidents and, consequently, a copy of Form 205 is not to be submitted on minor accidents.

Investigation of the accident.

Medical officers investigating aircraft accidents will obtain information from several sources: personal inspection of the aircraft and surrounding area, statements of survivors, statements of military witnesses especially the first medical officer to reach the scene, and statements of civilian witnesses will all furnish valuable data.

Description of the Physical Characteristics of a Crash

In any crash the following features are important:

1. Type of terrain.
2. Attitude and angle of plane in striking terrain.
3. Estimated speed of aircraft. This must, of course, be obtained from witnesses if all personnel in the plane have been killed.
4. Estimated stopping distance (in feet). This may be determined from skid or other marks on the ground and the condition of trees in the vicinity.
5. Attitude at which plane came to rest.
6. Decelerative forces encountered. This information may be obtained from the data furnished by 3. and 4. above provided that the deceleration is uniform. If the speed (in miles per hour) and the stopping distance (in feet) are known, the deceleration in g is determined by the formula: $g = .034 \frac{(\text{m.p.h.})^2}{s}$ where m.p.h. is the speed in miles per hour and s is the stopping distance in feet. This is, of course, the deceleration of the aircraft, and not necessarily of the passengers.

Escape Procedures in Crash Landings on the Ground

1. Were hatches opened before impact of plane with the ground?
2. Which escape hatches were used and by whom?
3. Was there any malfunction of escape hatches? If so, determine why.
4. Were hatches large enough?

Presence of Fire

1. How soon after the crash did fire break out?
2. What facilities for fighting it were present? Were these adequate?
3. Determine whether:
   a. Burns alone were sustained;
   b. Burns were sustained as a result of injuries which prevented escape from the aircraft;
   c. Burns were preceded by fatal trauma.

Water Landings (Ditching)

If plane crashed on the water, the following additional facts should be determined:

1. How long did the plane remain afloat?
2. Was crew trained in ditching procedures?
3. Was anyone injured or killed by the impact? Determine whether:
   a. Drowning occurred without evidence of other injury;
   b. Drowning occurred as a result of other injury;
   c. Immersion occurred following traumatic death.
4. Did escape hatches function properly?
5. In multiplace aircraft, which escape hatches were used and by whom? Were hatches large enough?
6. Was the Mae West or other type of life vest worn and did it function satisfactorily?
7. How long were individuals in the water before being rescued?
8. Did life rafts function satisfactorily?

9. Was other emergency equipment available, e.g.: flares, radio, exposure suits, sea marker, rations, signalling mirror, fishing tackle, and sunburn ointment?

10. How was rescue effected?

11. What was the temperature of the water?

Parachute Escape

1. Type of parachute supplied each individual.

2. Altitude and attitude of plane when escape was made.

3. How was escape made? Was plane under control?

4. If person was injured in exit, identify structures producing the injury; that is, stabilizer, wing, propeller, bomb bay door, etc.

5. What, if any, parachute training the individual had received.

Personnel in Plane

The following information should be obtained for each individual in the plane:

1. If possible, ascertain the position in the plane at the time of the crash; that is, where individual was sitting, standing, lying, or kneeling.

2. What preparation, if any, was made for the crash?

3. If position changed, determine where and in what position the body came to rest.

4. Identify aircraft structures with which parts of body came in contact: windshield, instruments; control stick, wheel or column; glass; transparent plastic; etc.

5. Determine condition of all cockpits, evaluating the degree of damage.

6. Ascertain specific injuries received by each individual (see below).

Specific Materiel Factors in Relation to Injury

Determine the status of each of the following for each person:

1. Seat belt: Was one available? If so, was it fastened, unfastened, too loose? Did the webbing tear; attachments fail; or buckle break?

2. Shoulder harness: Was one available? If so, was it used or not? Was it locked or too loose? Did the lock or the webbing fail?

3. Seats: Was a seat provided for everyone? If not, did this have any bearing on the injuries received? Was the seat intact? If not, how did it fail?

4. Oxygen equipment: If this equipment is considered a factor in producing the accident, determine: Any evidence of faulty maintenance? Evidence of inadequate instruction? Malfunction of regulator? Malfunction of mask? Malfunction of cylinders? AAF Regulation 55-7, "Personal Equipment Officer," requires that the flight surgeon and personal equipment officer furnish a report to the Air Surgeon of "each accident or death to flying personnel caused in whole or in part by malfunctioning of oxygen equipment, lack of oxygen equipment, inadequate knowledge of the use of oxygen equipment, or by malfunctioning or lack of any emergency or rescue equipment."

Records.

Within the continental limits of the U. S., AAF Form No. 205, revised, will be accomplished in quadruplicate by the medical officer who is a member of the Aircraft Accident Investigating Board. Although directions accompanying the form state that it is to be filled out not later than 14 days following the accident, it will not be submitted until the medical investigating officer has met with the Accident Investigation Board (See Section 3-8).

Form 205 will be classified as RESTRICTED, within the continental U. S. Letters of transmittal are not necessary. Request for acknowledgment of receipt of Form 205 should not be made.

DISTRIBUTION OF FORM 205

ORIGINAL AND 1 COPY OF FORM 14	Air Surgeon
SECOND COPY	Chief, Office of Flying Safety
THIRD COPY	Through channels to surgeon of command to which personnel involved in accident are assigned.
FOURTH COPY	Files of medical officer of board

Separate entries on Form 205 are to be made as follows:

Station investigating accident. Give name and location of air base or station of the Accident Investigation Board.

Place of accident. Give name and location of air base or station at which accident occurred. If the accident occurred away, give approximate distance and direction from nearest air base with its location. For example, 5 miles NW of Tonopah Army Air Field, Nevada.

Plane type and serial number. For example, B-17G 42-31654.

Mission. Give actual purpose and authority of the flight, including origin and destination of mission. For example, Scheduled cross-country ferry flight from Cheyenne, Wyo., to Army Air Base, Kearney, Neb.

Date accident. Use official military order: Day in numerals, month abbreviated, and year abbreviated. or example, 15 Dec 43.

Time accident. Use 24 hour time. For example, 0930.

Manner of occurrence and probable cause of accident. This information will be ascertained by the medical investigation officer from his own study and from the other members of the Accident Investigation Board. The data furnished should be a concise narrative of the events leading up to the accident in which the nature and contributing causes are stated. Information dealing with personnel is especially valuable.

Pilot name and grade. Indicate surname, first name, and middle initial, e.g. Smith, James J. Indicate grade in this space, e.g. 1st Lt, S/Sgt.

A.S.N. Indicate army serial number.

Age. Indicate age in years to nearest birthday.

Rating. Indicate flying rating. For example, pilot, service pilot, command pilot, glider pilot, etc.

Total pilot hours. These may be obtained from Form 14 or Form 5.

No. previous accidents. If information is available, give number of previous accidents in which this pilot was involved.

History of physical or neuropsychic defects. List any physiological factors including fatigue which may have had a bearing on this accident. The duration of the flight and the nature of the mission should be considered in evaluating fatigue. In addition, a most important factor may be previous combat flying. Determine, if possible, whether the pilot charged with the accident has participated in combat missions at any time and determine the number of hours flown or number of missions. Anoxia and carbon monoxide poisoning should also be evaluated as possible causes of the accident.

Injuries to Personnel. Give details for each individual killed or injured. Use other spaces or additional sheet if needed.

Name and grade:—Indicate surname, first name, and middle initial. In addition, indicate grade in this space.

Station:—Indicate home station of individual and its location.

A.S.N.—Indicate army serial number.

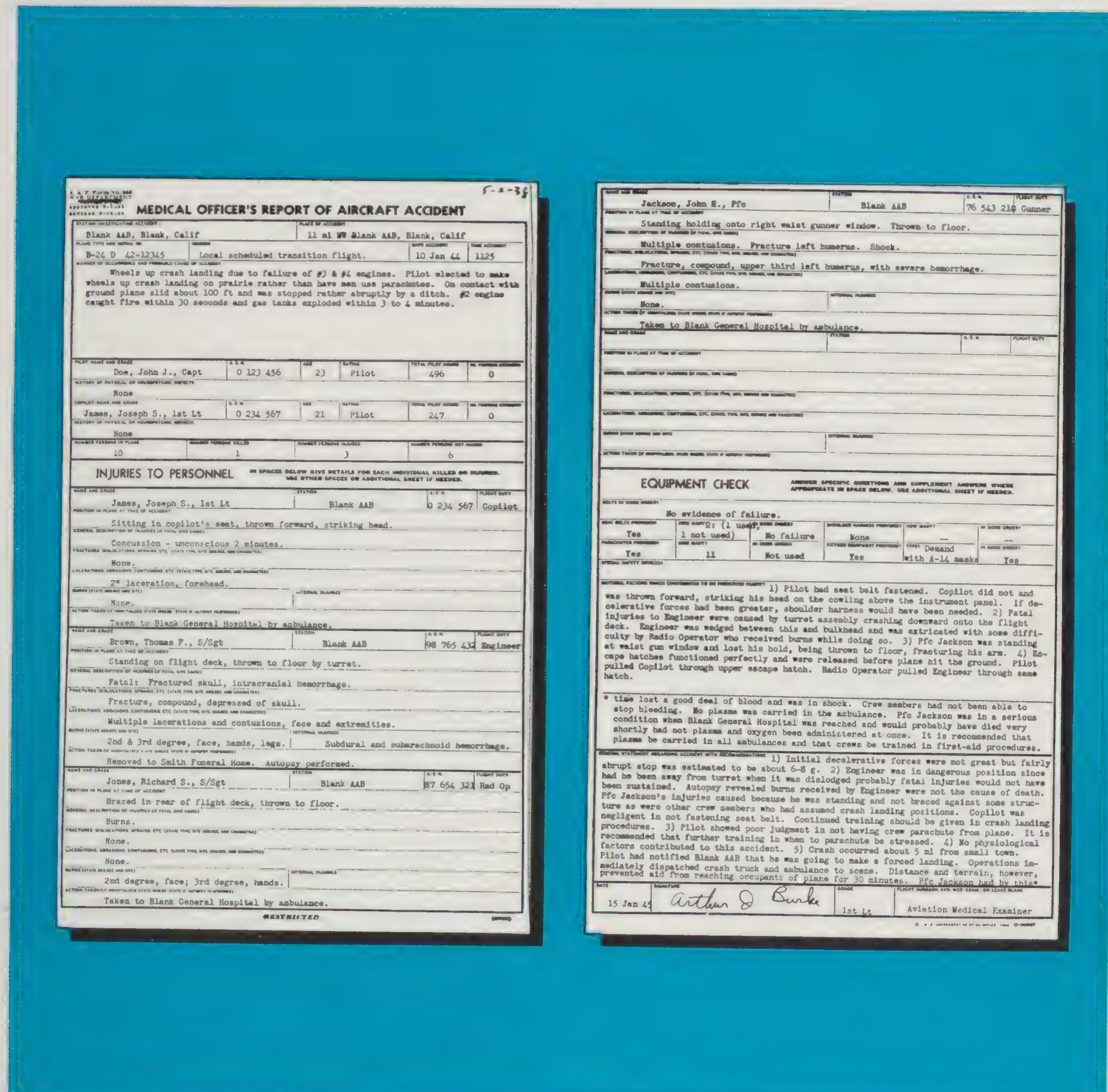
Flight Duty:—Indicate individual's job in plane at the time of the accident. For example, pilot, navigator, student, civilian instructor, etc. The heading "Flight Duty" does not mean line of duty.

Position in plane at time of accident: State where individual was sitting, standing, lying or kneeling at time of crash. If position changed, so state and where.

Injury: Give a brief "General Description of injuries." If fatal, state "Fatal." For example, "Fatal. Compound fracture of skull and multiple fractures of other bones." If fatal, give most probable cause of death.

State in this space when there has been disintegration, decapitation, evisceration, or cremation. X-ray examination of the body will often furnish additional and valuable information on the site of fractures, especially those of the vertebrae which may be difficult to find at autopsy. Categorize all injuries in the appropriate spaces giving site, degree, and character, or any other descriptive facts. Pictures of injuries sustained are especially valuable and should be included whenever possible.

Action taken: State what action was taken with respect to injured personnel; that is, local treatment or whether hospitalized and where. If returned to duty, so state. If fatal, state whether autopsy was performed and where. The medical investigation officer should see to it that an autopsy is performed whenever possible. Up to the present time, medical officers have been satisfied to determine the cause of death by the external appearance of the body and have usually not deemed an autopsy necessary. If accurate information as to the *exact degree of injury* sustained in aircraft accidents is ever to be obtained, there must be adequate data based on a complete examination of the body. In addition, sometimes there may be no external marks on the body. Army Regulations 40-590 authorize an autopsy on all persons in military service dying from any cause. The Director, Army Institute of Pathology, Army Medical Museum, wants complete autopsy reports on person-



5-2-38

MEDICAL OFFICER'S REPORT OF AIRCRAFT ACCIDENT

Blank AAB, Blank, Calif — 11 mi NW Blank AAB, Blank, Calif

B-24 D 42-12345 — Local scheduled transition flight. — 10 Jan 44 — 1125

Wheels up crash landing due to failure of #3 & #4 engines. Pilot elected to make wheels up crash landing on prairie rather than have men use parachutes. On contact with ground plane slid about 100 ft and was stopped rather abruptly by a ditch. #2 engine caught fire within 30 seconds and gas tanks exploded within 3 to 4 minutes.

Doe, John J., Capt	0 123 456	23	Pilot	496	0

None

James, Joseph S., 1st Lt	0 234 567	21	Pilot	247	0

None

10	1	3	6

INJURIES TO PERSONNEL

James, Joseph S., 1st Lt — Blank AAB — 0 234 567 — Copilot
Sitting in copilot's seat, thrown forward, striking head.
Concussion - unconscious 2 minutes.
None.
2" laceration, forehead.
None.
Taken to Blank General Hospital by ambulance.

Brown, Thomas F., S/Sgt — Blank AAB — 98 765 432 — Engineer
Standing on flight deck, thrown to floor by turret.
Fatal: Fractured skull, intracranial hemorrhage.
Fracture, compound, depressed of skull.
Multiple lacerations and contusions, face and extremities.
2nd & 3rd degree, face, hands, legs. — Subdural and subarachnoid hemorrhage.
Removed to Smith Funeral Home. Autopsy performed.

Jones, Richard S., S/Sgt — Blank AAB — 87 654 321 — Rad Op
Braced in rear of flight deck, thrown to floor.
Burns.
None.
None.
2nd degree, face; 3rd degree, hands.
Taken to Blank General Hospital by ambulance.

RESTRICTED

Jackson, John E., Pfc — Blank AAB — 76 543 210 — Gunner
Standing holding onto right waist gunner window. Thrown to floor.
Multiple contusions. Fracture left humerus. Shock.
Fracture, compound, upper third left humerus, with severe hemorrhage.
Multiple contusions.
None.
Taken to Blank General Hospital by ambulance.

EQUIPMENT CHECK

No evidence of failure.

Yes	2: (1 used, 1 not used)	No failure	None	—	—
Yes	11	Not used	Yes	Demand with A-14 masks	Yes

1) Pilot had seat belt fastened. Copilot did not and was thrown forward, striking his head on the cowling above the instrument panel. If decelerative forces had been greater, shoulder harness would have been needed. 2) Fatal injuries to Engineer were caused by turret assembly crashing downward onto the flight deck. Engineer was wedged between this and bulkhead and was extricated with some difficulty by Radio Operator who received burns while doing so. 3) Pfc Jackson was standing at waist gun window and lost his hold, being thrown to floor, fracturing his arm. 4) Escape hatches functioned perfectly and were released before plane hit the ground. Pilot pulled Copilot through upper escape hatch. Radio Operator pulled Engineer through same hatch.

* time lost a good deal of blood and was in shock. Crew members had not been able to stop bleeding. No plasma was carried in the ambulance. Pfc Jackson was in a serious condition when Blank General Hospital was reached and would probably have died very shortly had not plasma and oxygen been administered at once. It is recommended that plasma be carried in all ambulances and that crews be trained in first-aid procedures.

1) Initial decelerative forces were not great but fairly abrupt stop was estimated to be about 6-8 g. 2) Engineer was in dangerous position since had he been away from turret when it was dislodged probably fatal injuries would not have been sustained. Autopsy revealed burns received by Engineer were not the cause of death. Pfc Jackson's injuries caused because he was standing and not braced against some structure as were other crew members who had assumed crash landing positions. Copilot was negligent in not fastening seat belt. Continued training should be given in crash landing procedures. 3) Pilot showed poor judgment in not having crew parachute from plane. It is recommended that further training in when to parachute be stressed. 4) No physiological factors contributed to this accident. 5) Crash occurred about 5 mi from small town. Pilot had notified Blank AAB that he was going to make a forced landing. Operations immediately dispatched crash truck and ambulance to scene. Distance and terrain, however, prevented aid from reaching occupants of plane for 30 minutes. Pfc Jackson had by this*

15 Jan 45 — Arthur D Burke — 1st Lt — Aviation Medical Examiner

nel dying as a result of aircraft accidents. If facilities for performing an autopsy are not adequate, valuable information may sometimes be obtained by making small incisions in the thorax and abdomen. Such incisions should readily reveal whether hemorrhage has occurred in these cavities. Since traumatic rupture of the heart, lungs, liver, and spleen are commonly found in aircraft accident casualties, the presence of blood in the pericardial, pleural or peritoneal spaces would suggest these lesions and furnish a more accurate estimate of the cause of death.

Equipment Check. Answer specific questions and supplement answers where appropriate in proper space. Use additional sheet if needed. The information requested under "Equipment Check" is intended to furnish data regarding the use or availability of

certain protective devices in the crash as well as the behavior of other equipment which is intended for personnel use.

Seats in good order?—This means how did the seats withstand the impact of the crash? Did they remain solidly fixed to the aircraft structure or for example did the "seat in the rear cockpit break loose from its mooring causing occupant to be thrown forward, his head striking the instrument panel?" Careful attention to the condition of the seats will lead to recommendations on the strengthening of these structures.

Seat belts provided? — State number. "In good order" means were the seat belts in good order following the crash or did the webbing, attachments, or buckle fail?

Shoulder harness provided?—State whether harness was provided and how many. "In good order" means did it withstand the impact of the crash or did the webbing or lock fail?

Parachutes provided?—State whether parachutes were provided and the number. "In good order" means did the parachute function properly?

Oxygen equipment provided?—State yes or no. Designate type of regulator and mask. If either did not function properly, so state.

Materiel factors which contributed to or prevented injury. This should include a concise general statement dealing with how any injuries were sustained or prevented. This information will be based on data obtained by the medical investigation officer at the scene of the accident.

The following is a summary of the data which should be included; use a separate sheet if necessary:

1. Statement of efficacy of protective devices: seat belts, shoulder harness, seat, crash pad, etc. Were belts worn and did they function properly and prevent injury or fail and lead to injury?

2. With what structure, if any, did each individual come in contact? If injured, was it because position of individual changed or did structure become dislodged and strike the individual?

3. Did malfunctioning of other equipment lead to injury or did its use prevent injury; that is, parachutes, oxygen equipment, escape hatches, fire-fighting apparatus, etc.

General statement regarding accident with recommendations. The following are questions which the medical investigation officer should attempt to answer and on which he should, if possible, make specific recommendations:

1. How great were the decelerative forces?
2. Were individuals in safe or dangerous positions? Had they been previously trained in crash landing procedures?
3. Was training adequate with regard to safety devices: shoulder harness, oxygen equipment, parachute, etc.?
4. Were rescue and medical facilities adequate following this accident?
5. What steps, in your opinion, can be taken to prevent this type of accident?
6. What physiological factors, if any, contributed to this accident? Anoxia, fatigue, night blindness, carbon monoxide poisoning, etc., should be considered.

Information obtained from Form 205.

It is worthwhile to point out what constructive information was obtained from the data on the Form 205, illustrated above. A further need for training in crash landing procedures is obvious inasmuch as the copilot did not fasten his seat belt; the gunner, who had stationed himself at a point of exit, was unable to brace himself and was consequently injured; the engineer was in a dangerous position in this type of plane. If similar fatalities result in other crashes, recommendations can be made that the space occupied by this engineer be cleared in the event of a crash landing, and, in addition, that the turret attachments be strengthened. Autopsy proved that the engineer was killed by the injuries sustained in the impact rather than by the burns. This report also reveals the obvious need for carrying plasma in ambulances answering crash calls and the need for training air crews in first-aid procedure.

REFERENCES

AAF Manual 62-1, Aircraft accident investigators handbook, 1944.
AAF Reg. 55-7, Personal equipment officer, 28 Oct 1943.
AAF Reg. 15-205, Medical officer's report of aircraft accident, 1 Nov 1944.
AAF Reg. 62-14, Investigation and reporting of aircraft accidents, 20 Nov 1944.
AR 40-590, Administration of hospitals—general provisions, 2 Feb 1942.

Records in the Flight Surgeon's Office

Records maintained in the flight surgeon's office, although varying with the type of unit, usually include the following:

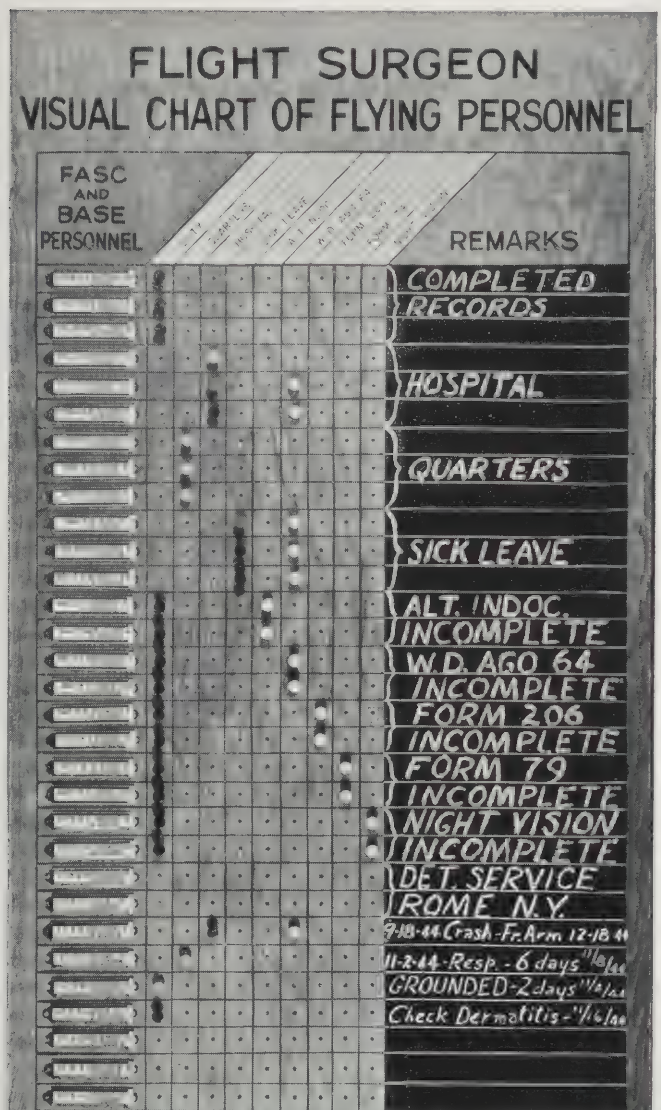
Policy File. A policy file of all directives, AAF letters, and other pertinent information or material concerned with the conducting of the office must be maintained.

Sick Report. The senior noncommissioned officer in charge of the flight surgeon's office should be responsible for the proper upkeep and preparation

of the Daily Diary and Daily Sick Report.

Visual Roster and Locator Chart. It is an advantage for the flight surgeon to be able to evaluate at a glance the status of all rated flying personnel of his unit. In small units, a visual roster and locator chart may be made out of plexiglas or other appropriate material, upon which the names of all rated flying personnel of an organization can be listed. Opposite each entry, columns may indicate aeronautical rating held, present flying status, sick report entry when appropriate, restrictions concerning flying, waivers authorized, immunizations completed, and dental care completed. Deficiencies concerning any of the above medical considerations may be entered by various colored wax crayons having a code significance. The visual roster locator chart should be placed on the wall in the flight surgeon's office in his direct view. It must be maintained daily by himself or his noncommissioned assistant. In installations where several types of organizations are located, several charts may be maintained, such as one chart for base personnel and another chart for personnel undergoing transitional training. Schedules for medical training of flyers can also be added to the contents of this chart with various designations for stages of completion of training.

Another visual chart may be made with plywood and pegs; an example of this type is shown.



FLIGHT SURGEON'S VISUAL CHART OF FLYING PERSONNEL

The colors used for the rivets are as follows:

Green — Duty
Yellow — Grounding
Orange — Temporary Suspension
Red — Indefinite Suspension
White — Used to indicate incomplete physical examinations and forms necessary in maintaining current flight surgeon records.

Flight surgeon's record (Traveling File or "64" File).

In order to obtain a comprehensive over-all picture of the physical and mental make-up of rated flying personnel, it is necessary that the traveling "Flight Surgeon's Record" contain complete pertinent information. The following should be progressively accumulated in the record during the period of military service of the concerned flyer:

1. Orders designating aeronautical ratings.
2. Orders designating a change in flying status.
3. Physical examination record for entrance to flying training and for aeronautical rating; each successive physical examination for flying conducted during period of service, including annuals, examinations conducted after serious illness or injury, examinations conducted for purposes of promotion, and any other special examinations.
4. Copies of the Immunization Register with appended information concerning spectacles, dentures, blood type, and sensitivity to drugs.
5. Records of waivers granted concerning physical defects.
6. Record concerning restrictions in flying duties.
7. Record concerning altitude indoctrination.

CHART A

PERSONAL RECORD SUMMARY

(For Inclusion in Flight Surgeon's Traveling File)

Name—Last First M.N.	A.S.N.	Date of Birth	AAF Station & Date
	Enl. Off.		

EDUCATION	ACTIVITIES (Sports-Clubs)	CIVILIAN OCCUPATIONS (Include civilian flying)

FAMILY HISTORY

MARITAL HISTORY

MEDICAL HISTORY PRIOR TO MILITARY SERVICE

MEDICAL HISTORY DURING MILITARY SERVICE PRIOR TO FLYING DUTY

8. Record concerning aircraft accidents in which rated members are involved.

9. Extracts of Medical Disposition Board proceedings or clinical records which are considered pertinent to the medical history of the individual.

10. Records concerning service in foreign theaters and extracts of illnesses or injuries concerning such service.

The following chart is suggested as a method of sequential entries by flight surgeons in the traveling file. Part "A" of the chart should include a complete history of the individual as outlined giving all facts and circumstances in his history which might have a bearing on his flying duties. Part "B" of the chart should consist of a progressive medical record accomplished by the flight surgeon of each successive station or unit to which the individual is assigned. Each flight surgeon must enter significant information concerned with the medical health of this individual in this section. Upon transfer of the flyer between assignments, the flight surgeon should make an entry concerning flying status at the time of transfer and sign it with his full name and organization designation. A double ruling in the form would then separate this entry from the entry of the flight surgeon of the succeeding station.

CHART B

FLYING PERSONNEL PROGRESSIVE MEDICAL RECORD

(For Inclusion in Flight Surgeon's Traveling File)

Name	A.S.N.	Aeronautical Rating(s)	Date of Birth

Date	Entry	Flying Status	Hq. Order & Date
15 Sept. 42	Phys. exam.—classification; P9 N8 B7; Qualified, Cl. I		
1 Oct. 42	Tfd. Maxwell Fld., Ala.		Keesler Fld., 25 Sept. 42
	C. A. Brown Capt., M.C.		
2 Oct. 42	Ar. Maxwell Fld., Ala., Preflight		
4 Oct. 42	Altitude indoctrination, Type 1, Flight, satis.		
6 Oct. 42	Altitude indoctrination, Type 2, Flight, satis.		
1 Dec. 42	Tfd. CPS, Arcadia, Fla.		Maxwell Fld., 29 Nov. 42
	J. A. Jones Capt., M.C.		
2 Dec. 42	Ar. Arcadia, Fla., placed on flying status	Full flying	2146 BU, 4 Dec. 42
1 Jan. 43	DNIF—bronchitis	Grounded	2146 BU, 1 Jan. 43
15 Jan. 43	Phys. exam.—return to flying, qualified	Full flying	2146 BU, 12 Jan. 43
15 Feb. 43	Tfd. BFS, Bainbridge, Ga.	Full flying	2146 BU, 14 Feb. 43
	A. J. Green 1st Lt., M.C.		
16 Feb. 43	Ar BFS, Bainbridge, Ga.	Full flying	
1 Mar. 43	Fracture, rt. tibia, aircraft accident, ground loop	Temp. susp.	Hq. EFTC, 10 Mar.
4 May 43	Phys. exam., return to flying, fract. well healed	Full flying	Hq. EFTC, 7 May 43
16 Aug. 43	Tfd. Spence Field, Moultrie, Ga., AFS	Full flying	Bainbridge AAF, 14 Aug. 44
	L. E. Smith Capt., M.C.		
17 Aug. 43	Ar. Spence Field, Moultrie, Ga., AFS	Full flying	
10 Dec. 43	Phys. exam. for appt. & rating, qualified, Class II, VA 20/30 each eye, correctible ē R—0.75 S; L—0.75 S.	Full flying	
15 Dec. 43	Waiver for Class II VA 20/30 each eye, correctible to 20/20	Full flying	Hq. EFTC, 15 Dec. 43
17 Dec. 43	Appt. 2nd Lt., AUS, AC.		Hq. EFTC, 17 Dec. 43
17 Dec. 43	Rated pilot		Hq. EFTC, 17 Dec. 43
17 Dec. 43	Placed on flying status	Full flying	Par. 18, P.O. 342 17 Dec. 43, Hq. EFTC.
19 Dec. 43	Tfd. AAB Richmond, Va.	Full flying	Hq. Spence Fld. 18 Dec. 43
	H. T. Lane Capt., M.C.		

Record progressively incidents in the military service which affect the flying duty or the physical condition of the individual. Include serious illnesses or injuries; purpose and result of all physical examinations; purpose and result of appearance before a Flying Evaluation Board or a Central Medical Examining Board; changes in flying status; altitude indoctrination; aircraft accidents; disciplinary actions; waivers granted for physical defects and restrictions placed on flying duty. Upon permanent transfer of an individual, the flight surgeon of the current station or unit of assignment will make the final entry of transfer at the time of transfer. He will sign his name and organization and draw a double line across the page, terminating the entries for a particular station. The flight surgeon at the new station will record the date of arrival and flying status, making note of any interval change. Pertinent entries relative to the above factors will be recorded in the AAF Form 206 of the individual. When additional entries are required, supporting addenda will be placed in the flight surgeon's file.

RENDITION OF MEDICAL REPORTS

IN ZONE OF THE INTERIOR

Name of Form or Report	No. of Copies	When Prepared	When Submitted	Distribution: Surgeon General	Air Surgeon	Service Command Surgeon	Through Command Channels	AAF Command Surgeon	Through Medical Channels	As Prescribed by Higher HQ	Retained in Preparing Office
Daily Diary (No prescribed form)	1	Daily	Not submitted as a report								Original
Daily Sick Report WDAGO Form 5	1	Daily	Not submitted as a report								Original
Register of Sick and Wounded WDAGO Form 8-24	1	For each hospital admission	Not submitted as a report								Original
Transferred Card WDAGO Form 8-24	1	For each patient transferred	With report of sick and wounded by last receiving hospital	Originals							
Emergency Medical Tag WDMD Form 52b	1 or 2	For each aid station admission	With report of sick and wounded by last receiving medical installation	Original and sometimes the duplicate							
Field Medical Record WDMD Forms 52c and 52d	1 of each	For each field hospital admission	With report of sick and wounded by last receiving medical installation	Original of each							
Report of Sick and Wounded WDAGO Forms 8-23, 8-24; WDMD Forms 52b, 52c, 52d	5 or more	Monthly	By 5th of each month	Original	Copy	Copy		Copy		Copies	Copy
Report Sheet WDAGO Form 8-23	5 or more	Monthly	As part of report of sick and wounded	Original	Copy	Copy		Copy		Copies	Copy
Report Card WDAGO Form 8-24	1	On final disposition of patient	As part of report of sick and wounded	Original							
Copy for the Air Surgeon WDAGO Form 8-23, 8-24	1	Copy of each report card of flying personnel	As part of report of sick and wounded		Copy						
Remaining Card WDAGO Form 8-24	1	January 31st	Wiith report of sick and wounded for January 31st	Original							
Register Index WDAGO Form 8-24	1	For each hospital admission	Not submitted as a report								Original
Out-Patient Index WDAGO Form 8-24	1	For each out-patient treated	Not submitted as a report								Original
Other Indices WDAGO Form 8-24	1	See instructions	Not submitted as a report								Original
Register of Dental Patients WDMD Form 79	1	For each dental patient	Not submitted as a report								Original
Report of Dental Service WDMD Form 57	5 or more	Monthly	By 5th each month						Original & 3 copies	Copies	Copy
Syphilis Register WDAGO Form 8-114	1	For each syphilis patient	When case is closed	Original							
Treatment Record WDMD Form 78a	1	For each syphilis patient	Not submitted as a report							Retained by the patient	
Monthly Venereal Disease Statistical Report (military letter form)	5 or more	Last Friday each month	3 days after end of period				Original and 3 copies			Copies	Copy
Statistical Health Report WDMD Form 86ab	5 or more	As of Friday midnight	Saturday	Original	Copy	Copy		Copy		Copies	Copy
Sanitary Report (monthly type only and prepared in military letter form)	7 or more	Monthly	By 3rd of each month				Original and 5 copies			Copies	Copy

(Since it is considered to be impractical to attempt to include variations in this compendium, persons using it should consult references or other sources for information before accepting it as correct).

IN THEATRE OF OPERATIONS

Name of Form or Report	No. of Copies	When Prepared	When Submitted	Distribution: Through Medical Channels	Distribution: Through Command Channels	Distribution: Theatre Surgeon	Distribution: As Prescribed by Higher Authority	Distribution: Retained in Reporting Unit Office
Daily Diary (No prescribed form)	1	Daily	Not submitted as a report					Original
Daily Sick Report WD, AGO Form 5	1	Daily	Not submitted as a report					Original
Emergency Medical Tag WD, MD Form No. 52b	1 or 2	For each aid station admission	Monthly with copy of Report of Sick and Wounded which reaches the theatre surgeon by last receiving medical installation	Original and sometimes duplicate also				
Field Medical Record WD, MD Forms 52c and 52d	1 of each	For each field hospital admission	Same as EMT above	Original of each form				
Report of Sick and Wounded. WD, AGO Form 8-23 and WD, MD Forms 52b, 52c, and 52d	2 or more	Monthly	By the 5th of each month	Original of all forms, sometimes also duplicates of WD, MD Form 52b*			Copies of WD, AGO Form 8-23 only	Copy of WD, AGO Form 8-23 only
Report of Dental Service WD, MD Form 57	2 or more	Monthly	By the 5th of each month	Original			Copies in sufficient number for each higher echelon (when required)	Copy
Register of Dental Patients WD, MD Form 79	1	For each dental patient	Not submitted as a report					Original
Syphilis Register WD, MD Form 78	1	For each syphilis patient	When case is closed				Original	
Monthly Venereal Disease Statistical Report (Military Letter Form)	2 or more	Last Friday each month	Within 3 days after end of period		Original and sufficient copies for each succeeding higher echelon requiring a copy		Copies (See column headed "Through Command Channels")	Copy
Statistical Health Report WD, MD Form 86ab	Submitted weekly in telegraphic Form—2 or more	Weekly	Saturday of each week				Telegram through local message center who may require one or more copies of original message	Copy
	3	Last Friday each month	Last Saturday of each month	Original (for consolidation in such offices as may be directed by competent authority)**		Copy**		Copy
Sanitary Report, Monthly Type (In military letter form	2 or more	Monthly	3rd of each month		Original and sufficient copies for each higher echelon requiring a copy		Copies (See column headed "Through Command Channels")	Copy

*Submitted through elements of a tactical command through the surgeon thereof to the surgeon of an expeditionary or similar force for transmittal to the Surgeon General (Amounts to submission through medical channels)

**EXCEPTION: When in the opinion of competent authority a consolidation of reports by subdivisions of a theatre is more practicable or valuable, the consolidated report will be rendered by such subdivisions as directed by proper authority.

NOTE: Before assuming this compendium correct and prior to submission of reports check with next higher echelon in medical channels.

Check systems for rendition of reports.

To meet the administrative requirements of an organization and to insure prompt rendition of necessary reports, some type of check system will prove very helpful. Several such check systems are suggested.

Calendar Method. Prepare a chart outlined in accordance with the current month and list under each date the reports on that date.

"Tickler" System. Using a 3 x 5 inch filing cabinet, list on an index card the reports due on a certain date and file under that date.

Suspense File. Number 31 file folders consecutively and insert a memorandum in the appropriate folder for the reports due on that date.

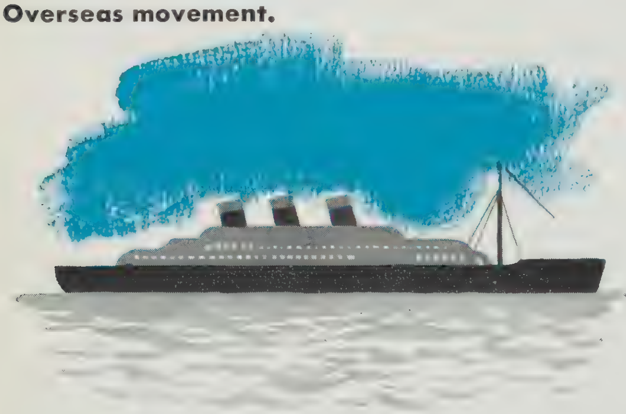
Locator Board Type Method. Prepare a board with the names of the reports in the vertical axis and the days of the month in the horizontal axis. Insert a peg for each report under the appropriate day.

PERSONNEL PROCESSING

Normal transfers (within the Continental U.S.).

The proper processing of AAF personnel and their records (including medical records), clothing, equipment and physical condition for transfer between stations or commands of the AAF within the U. S., is covered in AAF Manual 35-2. A check of medical forms and procedures will be made on enlisted men and on officers in accordance with the directions given in the manual.

Overseas movement.



There are certain medical requirements to be met in the processing of personnel for overseas duty. The details of these requirements may be found in the three War Department publications which bear the short titles of POM, Air-POM, and POR.

Discharge.

The procedure to be followed on discharging an enlisted man from the AAF because of disability may be found in TM 12-235.

REFERENCES

AAF Manual 35-2, Personnel processing manual, Sept 1944.

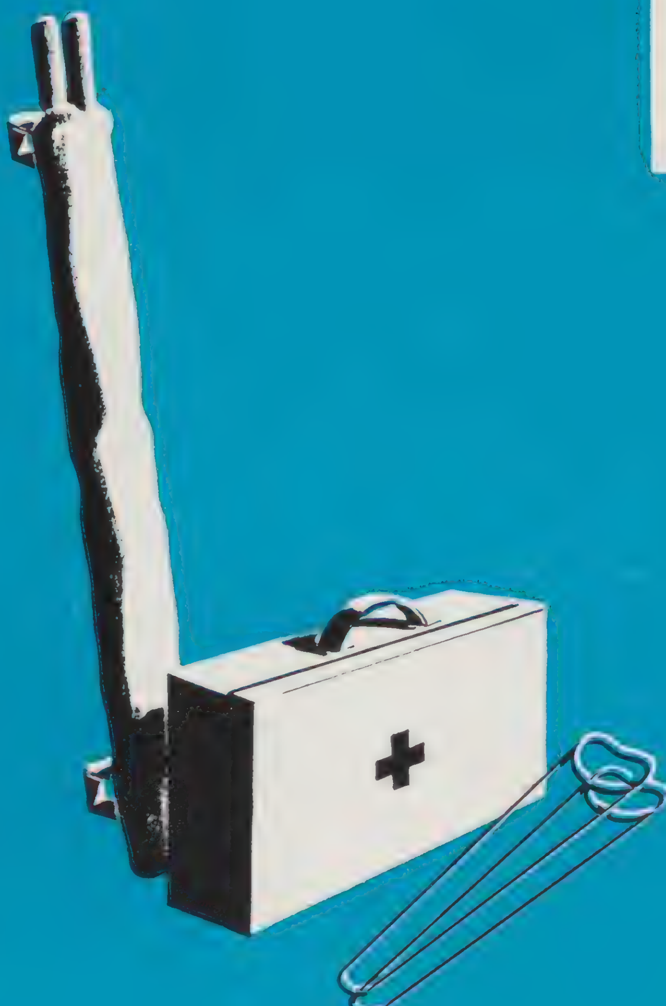
WD, Preparations for overseas movement (short title: POM), 2nd Ed., 1 Aug 1943.

WD, Additional preparation for overseas movement for AAF units (short title, Air-POM), 2nd Ed., 1 Aug 1943.

WD Pamphlet No. 29-2, POR, Preparation for overseas movement of individual replacements, 15 May 1944.

TM 12-235, Discharge and release from active duty, Jan 1945.

SECTION 6



MEDICAL SUPPLY AND EQUIPMENT

SECTION 6

MEDICAL SUPPLY AND EQUIPMENT

1. General.
2. Chain of Medical Supplies.
3. Aid Stations and Dispensary Equipment.
4. Items of Special Interest to the Flight Surgeon.
5. Crash Ambulance.

GENERAL

Items of Supply

Medical supplies and equipment furnished by the Medical Department are contained in ASF Catalog MED which consists of the following divisions:

MED 1—Introduction (to entire Medical Supply Catalog system).

MED 2—Index (to all sections of the Medical Supply Catalog).

MED 3—List of items for troops, posts, camps and stations.

Explanation and use of MED 3.

List of illustrations.

Classes of Medical Department items.

Index to MED 3.

MED 4—Allowances of expendable supplies (distributed in pamphlet form).

MED 6—Sets: small assemblies, kits, and chests.

MED 7—Organizational and higher echelon spare parts (distributed in pamphlet form, each pamphlet listing the spare parts available for one Medical Department item).

MED 9—List of all parts.

MED 10—Medical Department equipment lists.

In addition to ASF Catalog MED, information relative to the purpose, basis of issue, installation, requisitioning authority and method of distribution of certain medical items peculiar to the AAF is contained in the following publications:

ASC Regulation 65-73	T. O. No. 00-30-139
T. O. No. 01-1-117	T. O. No. 00-35A-25

Procurement

Tactical Units: The *original issue* of authorized allowances of medical equipment for units activated within the United States is furnished without requisition by means of shipping directives prepared by the Office of the Surgeon General in accordance with the supply plan prescribed by the War Department activation directive, as follows:

1. Shipment to the station of activation (TM 38-205).

2. Shipment to the station indicated in schedules applicable to the OTU program (WD Memo No. W700-17-43).

The issue of medical items required to *maintain the original* authorized allowance is made by the station medical supply officer in accordance with requisitions submitted by the unit supply officer (TM 38-205 and ASF Manual M403).

In preparation for overseas movement initial lists of medical shortages reflecting the medical items required to complete authorized allowances are prepared by the unit supply officer and the station medical supply officer for submission to the Office of the Surgeon General who prepares appropriate shipping directives (POM, 1 Aug 1943).

Stations: Medical supplies and equipment for stations are obtained by requisitions initiated by the station medical supply officer and submitted to designated depots through which the Surgeon General is responsible for review, revision, and approval of control levels of stocks at stations (TM 38-205 and TM 38-220).

Pertinent References Concerning Medical Supply

Regulations

AAF Reg. 65-1. Describes all aspects of supply and maintenance of AAF units, including the task force.

AAF Reg. 65-57. Prescribes the functions of the ATSC medical supply branches.

AAF Reg. 65-50. Describes plans and procedure of supply to OTU's.

AR 35-6520. Defines property accountability and responsibility applicable to medical supply officers.

AR 40-1705. Specifies definite responsibilities for medical supply officers.

ASC Reg. 65-73. Prescribes the operation of ATSC medical supply branches.

Technical Orders

T. O. 00-35A-25. Illustrates and prescribes the procedure for obtaining medical supplies peculiar to AAF.

T. O. 00-30-139. Prescribes the purpose, method of installation and basis of issue for medical kits peculiar to the AAF.

T. O. 01-1-117. Is concerned chiefly with the method of inspection and safeguarding of the Kit, First Aid, Aeronautic.

T. O. 00-35A-14. Prescribes detailed procedure of marking supplies for overseas shipments.

Technical Manuals

TM 38-401. Prescribes the use and preparation of the War Department shipping document.

TM 38-403. Provides detailed information relative to station supply procedure.

TM 38-205. Contains normal basic supply procedure in the continental U. S.

TM 38-220. Outlines the procedure of stock control for posts, camps, and stations.

ASF Manuals

ASF Manual M402. Provides information relative to depot storage.

ASF Manual M403. Describes station supply procedure.

Memoranda

WD Memos No. 700-17-43 and No. 700-37-43. Outline the plan and describe the procedure of supply to AAF tactical organizations designated as Operational Training Units.

Medical Supply Memos. These are prepared by Medical Depots and Medical Sections of ASF Depots and are issued to all stations within appropriate Distribution Areas and contain complete information relative to the procedure of supply from depot to station.

Letters

WD Letters bearing symbol SPX 400 (__) OB-S-SPDD1, subject, "Supply Plan for Army Air Forces Operational Training Units." These designate the AAF tactical organizations authorized to receive training equipment.

AAF Ltr. 65-3. Prescribes the method for establishing station movements.

Tables

T/A 1-26. Authorizes medical equipment for medical training centers engaged in training medical detachments for depot and service groups.

T/BA No. 1. Contains basic allowances of Medical Department items for AAF personnel and organizations.

Miscellaneous

The No. 8 series of WD Supply Bulletins. These supersede the SGO Circ. Ltrs. (Supply) and provide current information pertinent to medical supply activities.

POM and AIR-POM. Prescribes the preparation for overseas movements.

WD Directive AG 400.161 (__) OB-S-SPMOT-M. Provides further information relative to requisitioning and marking supplies for overseas shipments.

ASF Catalog MED. Lists the items that are stored and issued by the Medical Department and establishes the official item designation for use in the preparation of requisitions, records, reports and correspondence concerning medical supplies.

Equipment Guide for the Medical Dispensary (Avn), AAF, Medical Service Training School, 4 Jul 1944. Lists equipment, including weight and volume, allotted to Medical Dispensary (Avn) as prescribed in T. O. and E. 8-450.

Field Equipment, Medical Units and Sections, AAF Medical Service Training School, 10 Jan 1944. A graphic catalogue of medical field equipment, not to be used as a basis for requisition.

CHAIN OF MEDICAL SUPPLIES

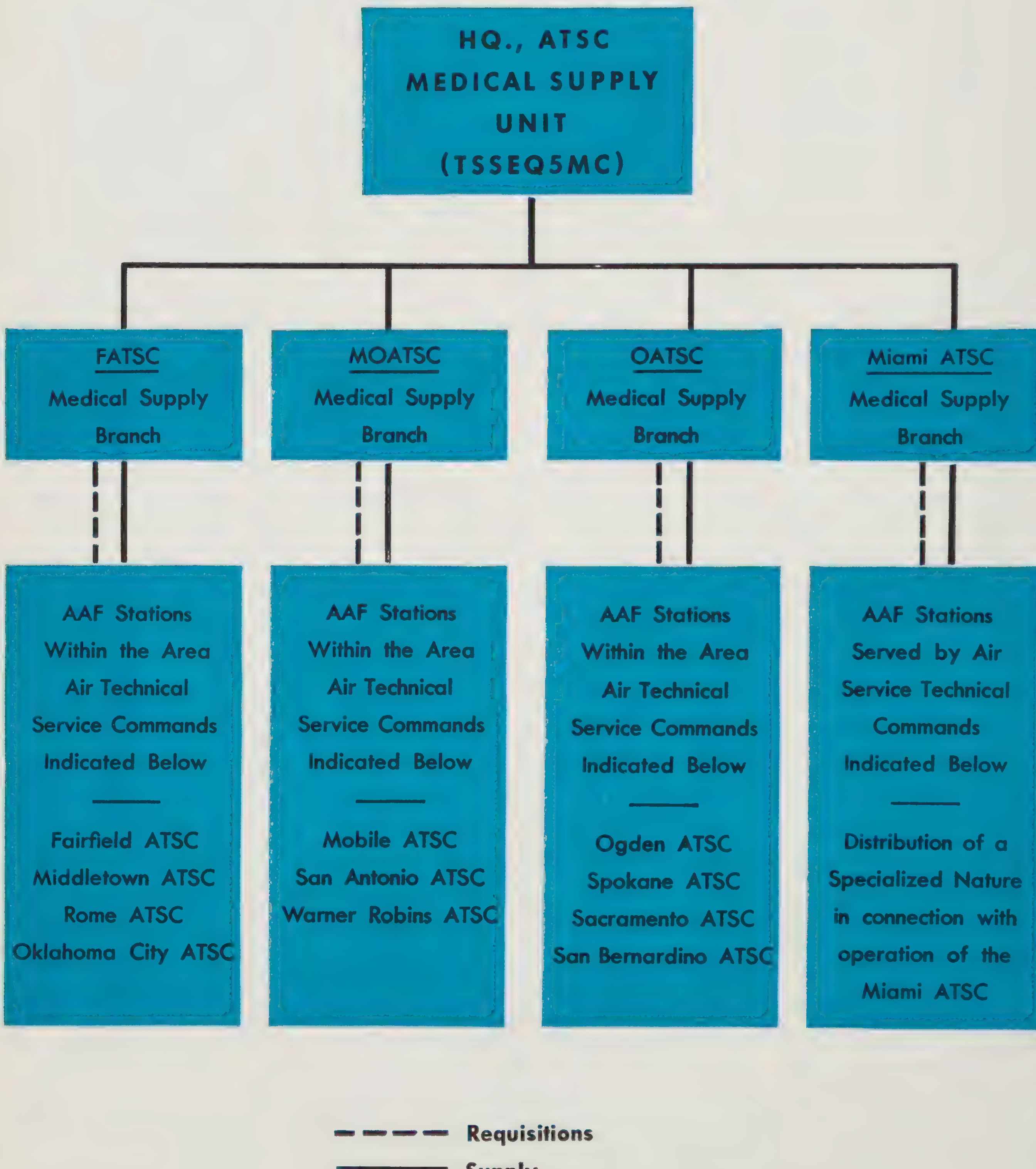
IN ZONE OF INTERIOR

SCHEMATIC PLAN FOR SUPPLY OF MEDICAL ITEMS COMMON TO THE AAF, ASF & AGF WITHIN THE UNITED STATES

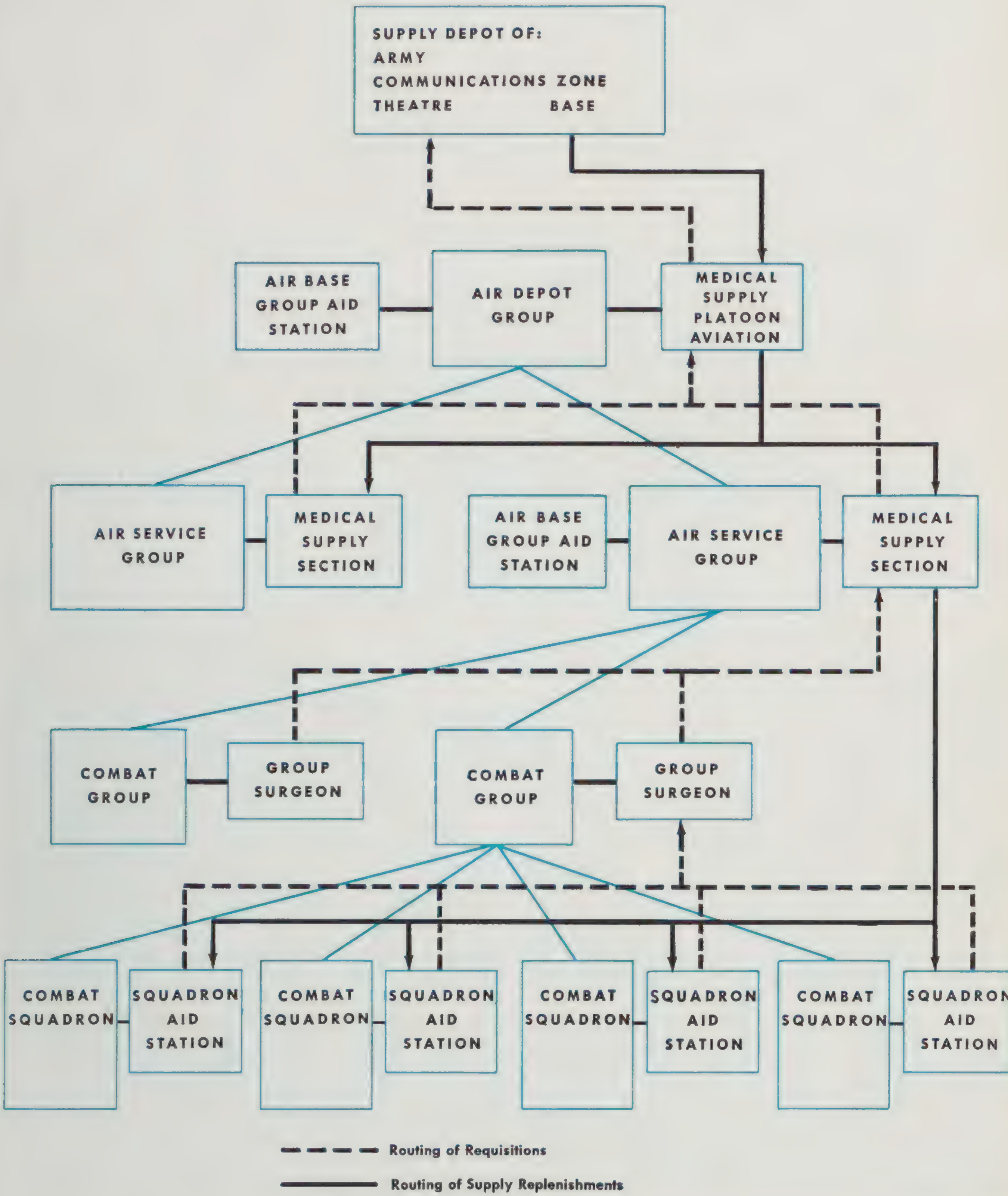
ASF
OFFICE OF SURGEON GENERAL

Seattle ASF Depot	San Francisco Med. Depot	Los Angeles Med. Depot	Denver Med. Depot	St. Louis Med. Depot	Savannah ASF Depot	Binghamton Med. Depot
Oregon	North California	South California	Arizona	Alabama	Florida	Connecticut
Washington	including:	including:	Colorado	Arkansas	Georgia	Delaware
	Bridgeport	Camp Roberts	Idaho	Illinois	No. Carolina	District of Columbia
	Presidio of Monterey	Hammer Fld	Montana	Indiana	So. Carolina	Maine
	Fort Ord		Nebraska	Iowa	Virginia	Maryland
	Hammond General Hospital		New Mexico	Kansas	less:	Massachusetts
			Nevada	Kentucky	Ft. Myer	New Hampshire
	Los Angeles Med. Depot		No. Dakota	Louisiana	Ft. Belvoir	New Jersey
			So. Dakota	Michigan		New York
			No. Texas	Minnesota		Pennsylvania
			West Texas	Mississippi		Rhode Island
			including:	Missouri		Vermont
			Sheppard Fld	Ohio		Ft. Myer, Va.
			Camp Walters	Oklahoma		Ft. Belvoir, Va.
			Camp Bowie	Tennessee		
			Curtiss Fld	East Texas		
			Wyoming	South Texas		
				West Virginia		
				Wisconsin		

SCHEMATIC PLAN FOR SUPPLY OF MEDICAL ITEMS PECULIAR TO THE AAF WITHIN THE UNITED STATES



CHAIN OF MEDICAL SUPPLIES IN THEATER OF OPERATIONS



AID STATION AND DISPENSARY EQUIPMENT

Squadron Aid Station Equipment (9730500)

The items of equipment enumerated below are components of the squadron aid station equipment, issued to medical detachments with squadrons, except detachments with headquarters squadrons of service and depot groups:

NO.	ITEM		QUANTITY
9746500	Blanket set, small	each	1
9754500	Chest, flight service, complete	each	1
9757500	Chest, MD, No. 4, complete	each	1
9774000	Crash splint unit	each	2
*9775600	Set, gas casualty, M-2	set	1
9782500	Surgical, dressings set	set	1
9938000	Litter, folding, aluminum	each	4
9938600	Litter securing straps	each	16
9938700	Machine, imprinting	each	1

*To be issued outside the continental limits of the U. S. when authorized by theater commanders.

Group Dispensary Equipment (9723875)

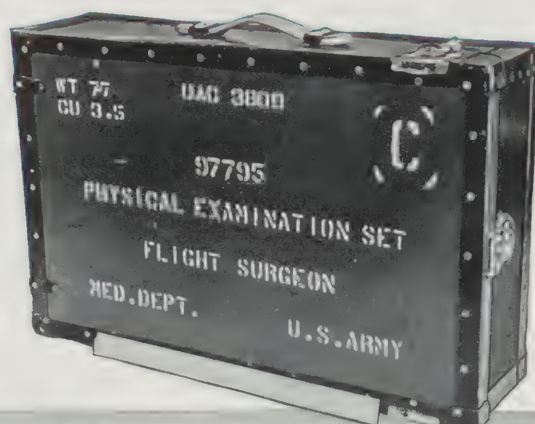
Items of equipment enumerated below are components of the group dispensary equipment, issued to medical detachments of headquarters squadrons of both air depot and air service groups:

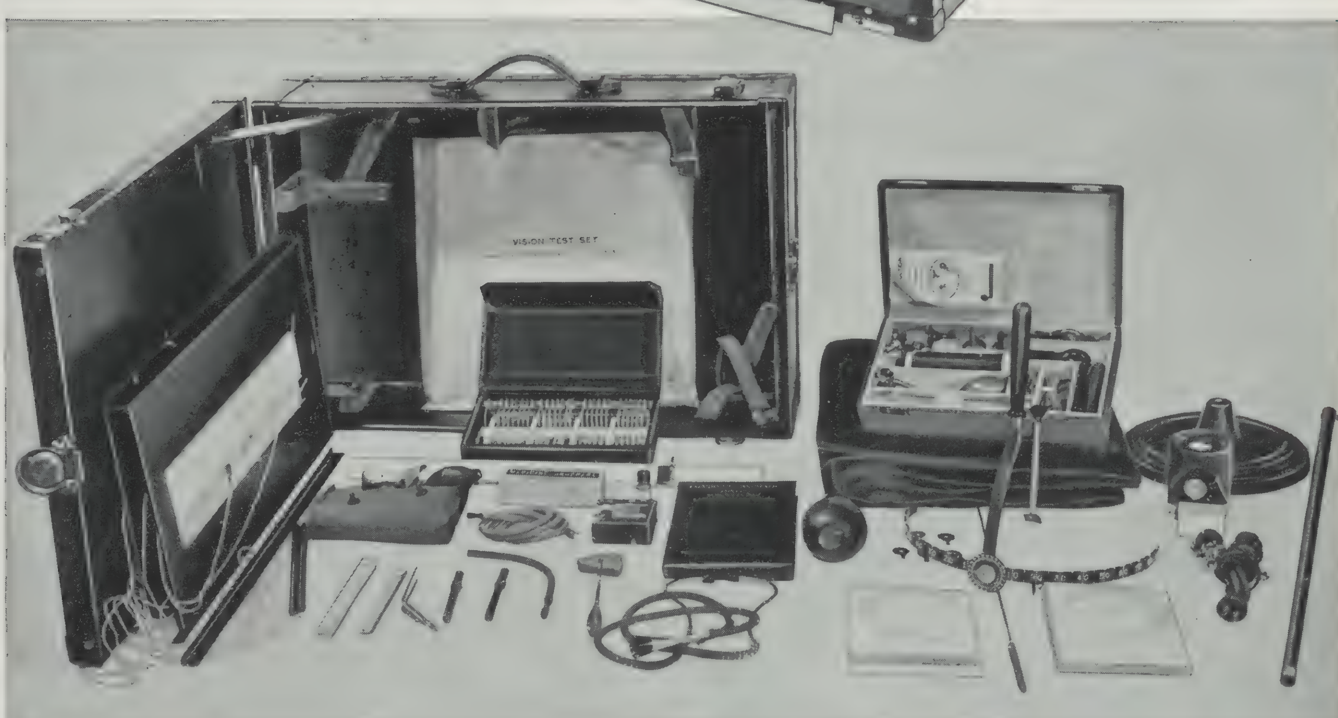
NO.	ITEM	QUANTITY
7751000	Chest, tool, small	1
9409500	Chest, laboratory, field	1
9502500	Chest, MD, No. 60, dental	1
9745000	Box of bedpans	1
9745500	Blanket set, large	1
9746500	Blanket set, small	3
9756500	Chest, MD, No. 1	1
9757000	Chest, MD, No. 2	1
9757500	Chest, MD, No. 4	1
9775600	Set, gas casualty, M-2	1
9777500	Lantern set	1
9779300	Pajama set, coat, winter	1
9779400	Pajama set, trouser, winter	1
9779500	Physical examination set, flight surgeon's	1
9781200	Pillow case set	1
9409500	Chest, laboratory, field	1
9745500	Blanket set, large	1
9775600	Set, gas casualty, M-2	1
9781400	Sheet set	1
9781500	Splint set	1
9782500	Surgical dressings	1
9784700	Towel set, bath	1
9784800	Towel set, hand	1
———	Items not included in chests, cases, etc., such as, drugs, dressings, instruments, mess equipment, administrative equipment	

ITEMS OF INTEREST TO THE FLIGHT SURGEON

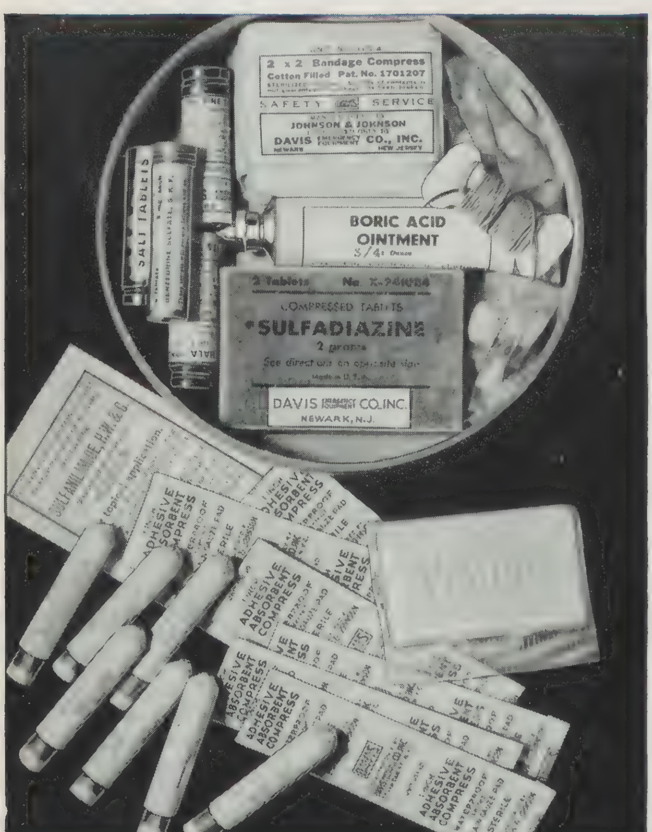
NO.	ITEM
97795	Physical examination set, flight surgeon's
9776500	Kit, first-aid, aeronautic, complete
9710600	Kit, first-aid, parachute (frying pan insert) Type B-4
9776300	Kit, first-aid, jungle, complete
9776200	Kit, first-aid, arctic, complete
97545	Chest, flight service, complete
9774000	Crash splint unit
9751700	Chest, ambulance, airplane, complete

Physical Examination Set, Flight Surgeon's





Kit, First Aid,
Aeronautic, Complete

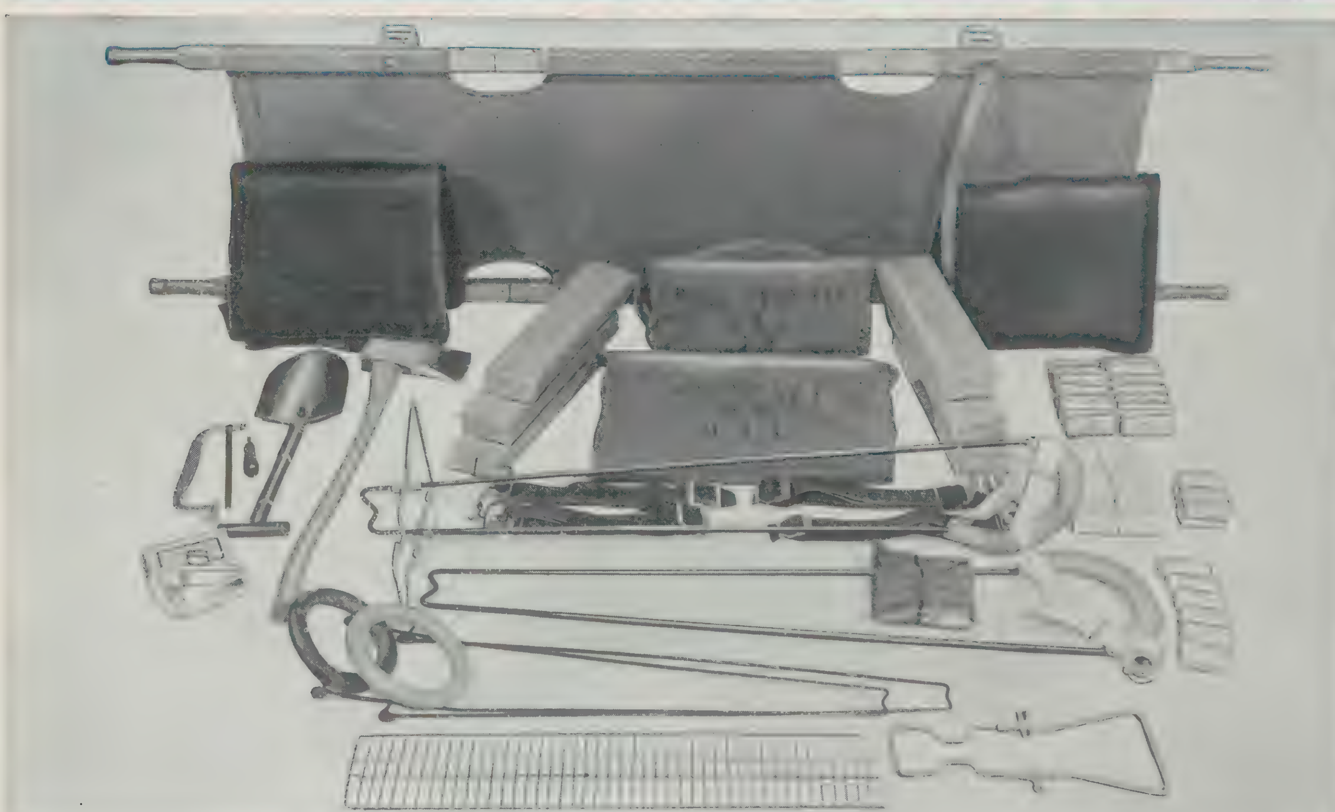


Kit,
First Aid,
Parachute
(Frying Pan
Insert)
Type B-4

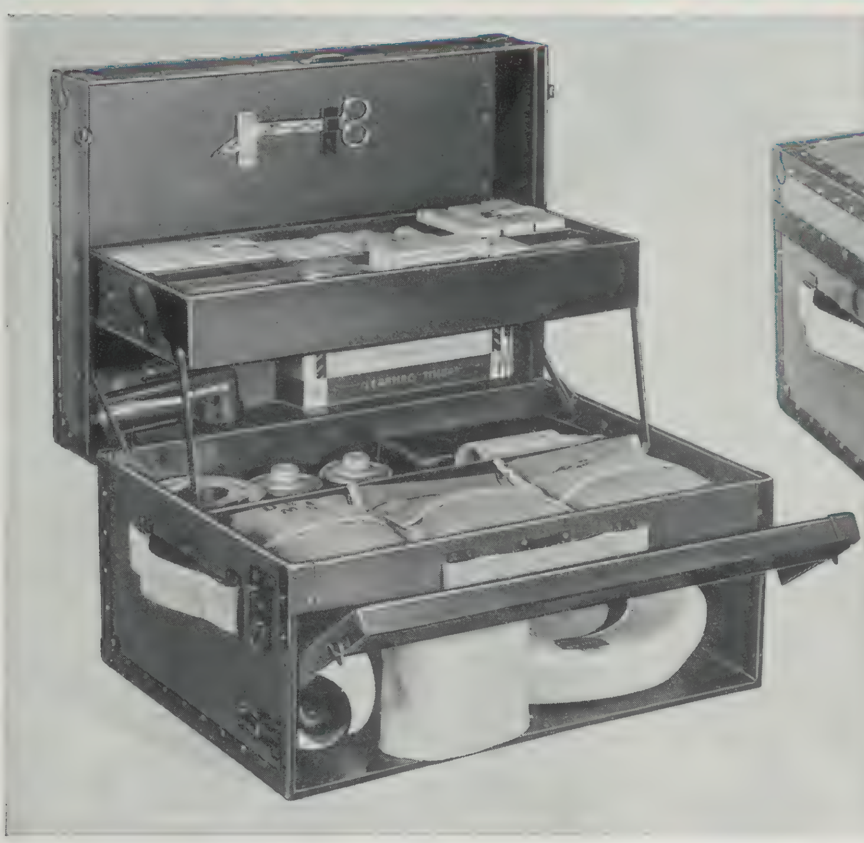
Kit, First Aid,
Jungle, Complete

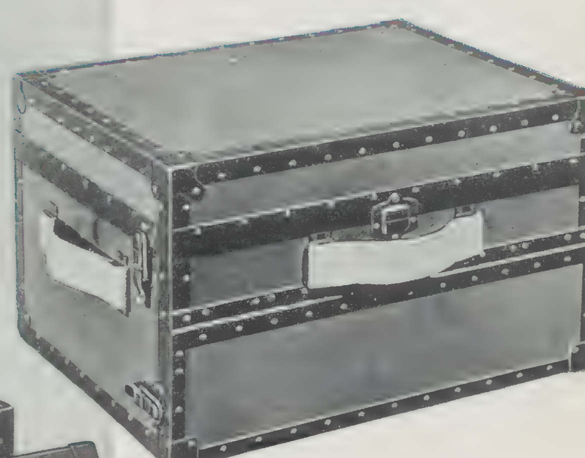
Kit, First Aid,
Arctic, Complete

Crash Splint Unit



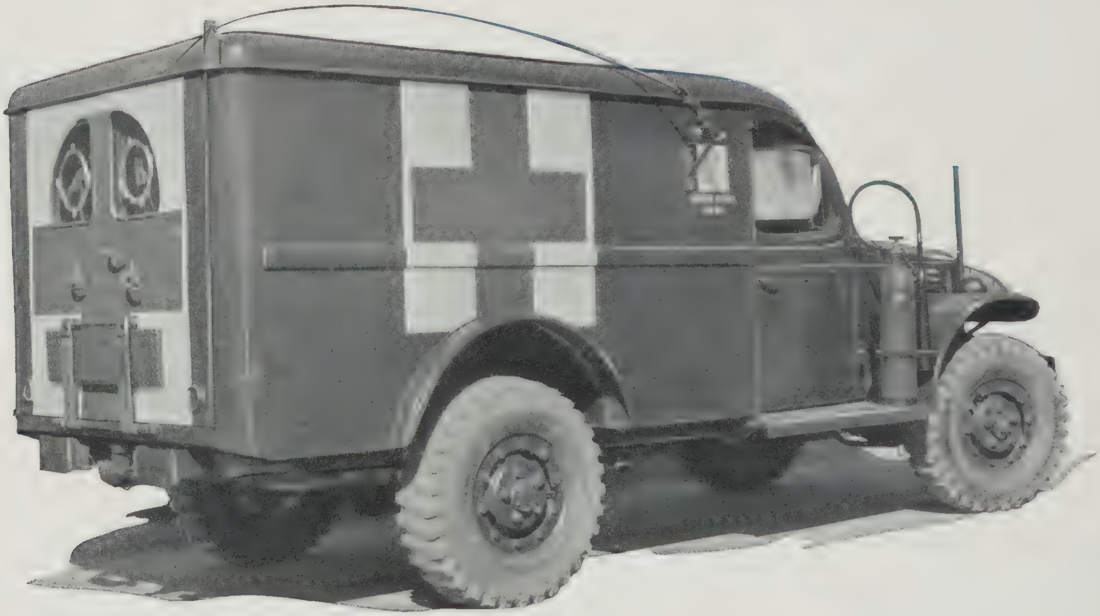
Chest, Flight
Service, Complete





Chest, Ambulance,
Airplane, Complete

CRASH AMBULANCE



In order to make available to all AAF bases satisfactory equipment and installation methods to modify ambulances for crash use, the Air Technical Service Command, working in conjunction with the Air Surgeon's Office and the Office of Flying Safety, has made a study of advantages and disadvantages of various crash ambulance modification features. An ambulance, modified to incorporate many of the most desirable and practical features, is under consideration by the Office of the Air Surgeon. The following features are incorporated in the installation:

Radio Antenna Installation. Satisfactory two-way ambulance-to-tower or ambulance-to-plane communication is possible at distances of fifteen or more miles in ordinary terrain. With the mounting shown, the antenna can be used projecting upward, at a 45 degree angle, or horizontally or down to prevent damage by wires, doorways, and trees. Ordinarily, only the small, flexible, terminal half of the standard antenna mast is required for good performance. In mountainous areas or at bases where an unusually long radius of two-way radio operation is desirable, a heavier base segment of the antenna may be added.

Fire Extinguisher Mounting. Standard mounting is used for a large carbon dioxide extinguisher.

Rear Window Ventilation. For hot climates, standard plate glass can be replaced by lucite or plexiglass windows with eight-inch holes. Port-hole covers of lucite or plexiglass can also be made in local air base shops. When not in use, port-hole covers are placed in standard airplane webbing litter-support stowage bags attached to inside of doors beneath windows. Loss of port-hole covers is prevented by cords connecting covers to stowage bags.

Plug-in for Battery Charger. A 110-volt extension cord plugged into the fitting keeps the vehicle's battery charged to maximum at all times during which the ambulance is subject to call. If the driver neglects to unplug the extension cord before driving away, the extension cord plug will pull out of the plug-in fitting on the back of the ambulance and no damage will be done. On emergency trips, the battery is kept charged by keeping the engine running.

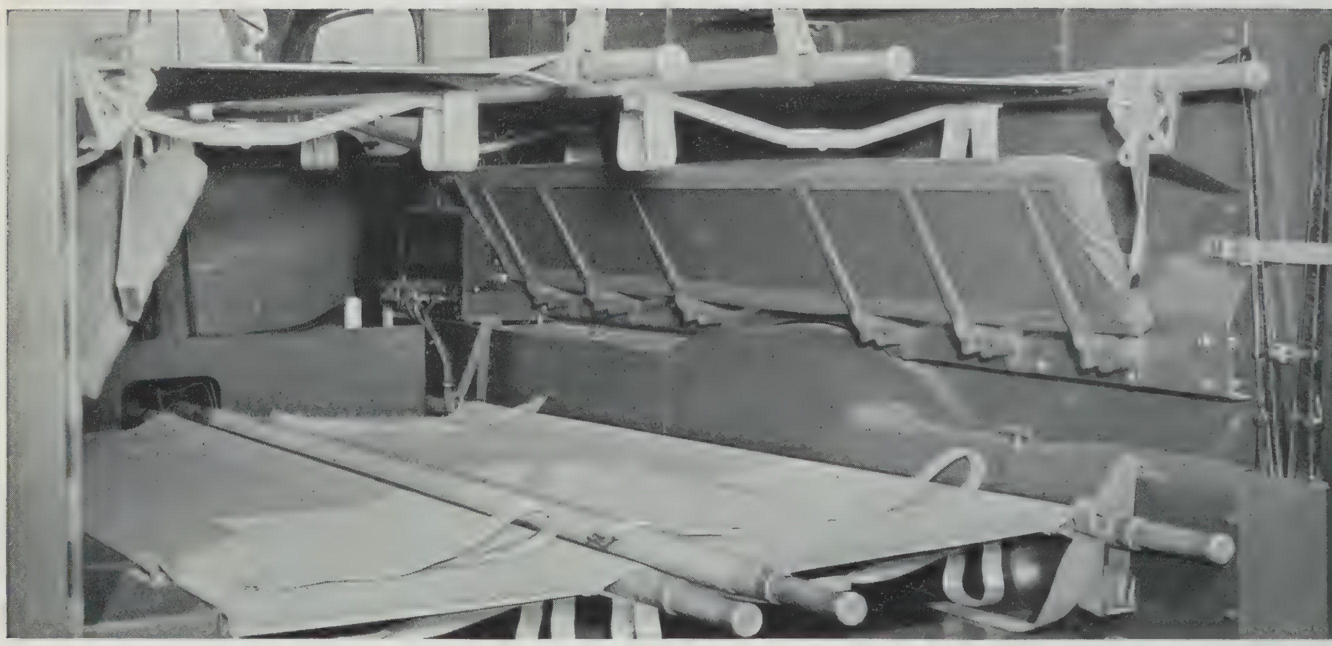
Crash Tools. A standard bolt-cutter (for cutting fences) is mounted near the right rear door and a standard fire-axe is mounted in the same location on the left side. An entrenching shovel and small pinch bar are carried in the tool box near the right rear door. The standard Pyrene extinguisher is mounted inside the ambulance just above the windshield.

Modified Litter Supports. Outboard poles of upper litters are secured by wall clamps of the type used in standard webbing litter-support installations in AAF cargo aircraft. This change prevents forward

Radio Receiver and Transmitter

sliding of upper litters, with resultant damage to oxygen equipment, when the ambulance stops suddenly. Tie-down fittings for lower litters are unchanged.

Medical Cases. Three cases, two large and one small, contain medical equipment. All cases are relatively shallow to avoid projection over litters and to make all contents immediately visible when cases are opened for use. Cases are supported on metal shelves and are secured to walls by straps. Case number 1 is mounted in a forward position on the right wall where it can be reached by the attendant in the right front seat. It is sufficiently small to be transported in the medical attendant's lap in an ambulance or in any type airplane, and is built to contain one unit of plasma, morphine, tourniquets, instru-



Ambulance Litter Installation

ments, dressings, sterile towels, and other equipment ordinarily most urgently needed for the first few minutes at a crash. Case number 2, mounted near the rear door on the right side, is designed to contain additional plasma units, dressings, sterile towels, sterile sheets, bandages, basswood splints, additional drugs, and other medical supplies considered necessary by the local base surgeon. Case number 3, mounted on the left side opposite case number 2, is designed to contain two sets of standard hinged ring splints (for arm and leg), two standard crash remains pouches, chemical heating pads, muslin bandages for use with ring splints, or other equipment required by the local base surgeon.

Therapeutic Oxygen Equipment. A standard therapeutic oxygen assembly, mounted in quick-detachable supports made from standard parts, is located behind the right front door. It provides a maximum flow of six liters per minute for thirty-five minutes, and the low pressure cylinder is easily recharged from either standard ground-servicing oxygen equipment or walk-around recharging hoses in AAF aircraft. An A-8 series mask is carried in the glove compartment of the ambulance. For patients with repeated vomiting or certain types of face injuries an A-7A mask or nasal catheter may be carried.

Two-way Radio Equipment. A sheet metal guard protects the transmitter and receiver from damage by floor litters but does not interfere with normal loading and location of litters. The receiver, which can be tuned to five frequencies, is located behind the driver's seat. Either the speaker or the headset (carried on a hook and between the seats) may be used. The 25-watt transmitter, which transmits on two frequencies, is mounted behind the right seat, and the power unit is mounted on the tool box just behind the right front door. The microphone is carried on a hook with the headset. The battery-charger, which connects with the plug-in on the rear of the ambulance, is mounted on a metal shelf with clips for spare fuses behind the left front door. Beneath the metal shelf are a ledge and strap which are provided to hold one standard one-quart thermos bottle if needed.

Normal Litter Capacity. With complete standard crash radio equipment, cases for adequate medical equipment and supplies, therapeutic oxygen equipment, and standard crash and fire-fighting equipment, a normal maximum capacity of 4 litter patients is maintained. All 4 are provided sufficient room and are not endangered by metal projections near them or over the litters. Although the metal shelves for medical cases do not permit an attendant to lean against the wall while sitting on the bench, they do not project sufficiently far from the wall to affect the usefulness of the benches in an ambulance assigned to crash duties.

SECTION 7

EXAMINATION OF THE FLYER

SECTION 7

EXAMINATION OF THE FLYER

1. The General Examination.
2. The Eyes.
3. The Ear, Nose, and Throat.
4. The Dental Examination.
5. Testing of Aptitude.
6. The Psychological and Neuropsychiatric Examination.

THE GENERAL EXAMINATION

The Medical History

The collection of medical data from applicants for flying training and from rated flyers differs somewhat from the usual clinical history in that its primary purpose is to reveal to the examiner any diseases in the past or present which will disqualify the applicant for flying. Details of illnesses such as mode of onset, probable exciting cause, modifying factors—usually of interest to the clinician—are of no particular value. To this statement there are a few striking exceptions. In deciding whether an applicant for training did or did not have a disease known to be disqualifying it may be necessary to elicit details. An example is a history of valvular disease of the heart, often too gullibly accepted by the examiner. An applicant will frequently state that he was told he had a "leaky valve" in his heart in childhood. Obviously such a story cannot be accepted as a history of valvular heart disease unless other clinical and laboratory data, collected either in the past or in

the present, support this diagnosis. More often than not this proves to have been, on further study, an unexplained (functional) murmur. In this example a record of details would be imperative for reaching a conclusion, and must be included in the history.

Other diseases in which details must be obtained because of the possibility of an originally mistaken diagnosis are encephalitis lethargica, paroxysmal tachycardia, malaria, glomerulonephritis, rheumatic fever, renal calculus, epilepsy, and hay fever.

The use of the phrase "usual childhood diseases" on the original examination is decried. Most often it means that the medical officer has simply neglected to question the applicant about them. This may result in overlooking a disease like scarlet fever complicated by otitis media, nephritis, or cardiac valvular disease, historical facts which would make the subsequent physical examination infinitely easier and more precise. Childhood diseases should be listed but the exact date of each need not be given, the time being indicated simply as "in childhood" (under 12 years of age).

Many applicants will have learned before the examination about disqualifying factors. Considerable ingenuity must be used in eliciting a history from these individuals, and resort to circumvention often must be made.

The family history in general is of value in strengthening such past or present diagnoses in the applicant as rheumatic fever, tuberculosis, or mental disease. Other remote details are generally of little value.

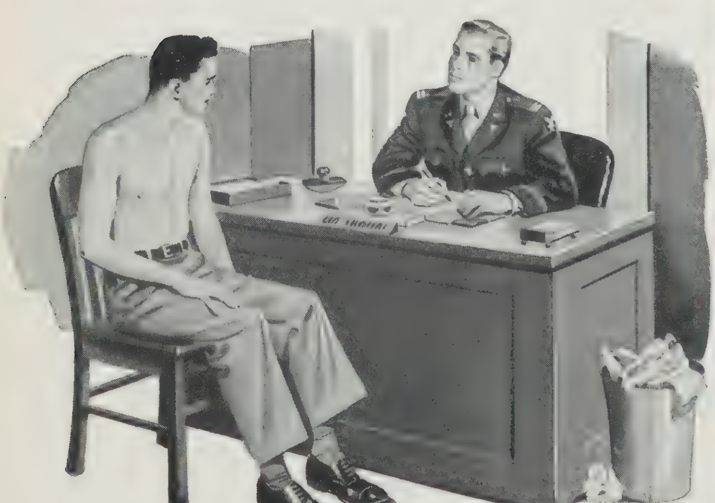
The scope of medical history on a reexamination will depend upon the reason for the examination.

The Physical Examination

The usual defects that may interfere with flying are sought in the extremities, heart, lungs, viscera, and genitourinary system. Some of the special procedures used are elaborated in following paragraphs. In addition, an attempt is made to evaluate the emotional stability of the applicant by the observation of certain physical signs which constitute the syndrome called "vasomotor or cardiovascular instability," and to evaluate his intelligence by the facility with which he follows simple directions.

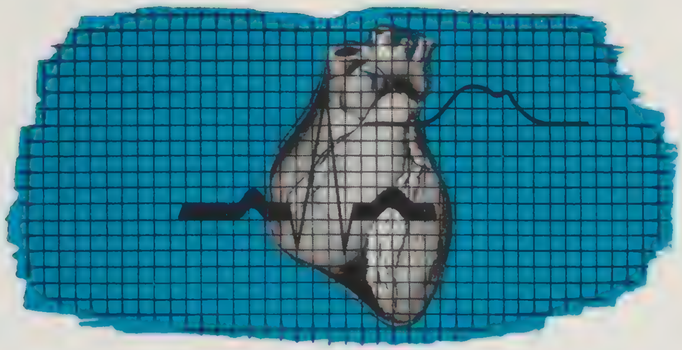
Vasomotor or Cardiovascular Instability

Definition. The term is used to describe a group of signs probably resulting from unusual activity of the sympathetic nervous system, or imbalance of the autonomic nervous system, in response to an emotional stimulus (see Section 7-6). In the case of original applicants the emotional stimulus is the strange environment of the flight surgeon's office. The manifestations listed below are probably present in some degree in all individuals depending upon the intensity of the emotional stimulus. If it is persistently present in marked degree in the original applicant for flying training, he is disqualified. The reason for this is that these individuals show a variable degree of psychomotor tension. When confronted by the strange environment of the airplane cockpit and exposed to the additional uncertainty of loss of reference to the ground, they do not learn to fly or else they learn to fly with difficulty because of the tenseness associated with these emotional stimuli.



Manifestations

Labile pulse, often rapid.
Labile blood pressure; frequently high systolic.
Cold, clammy, cyanotic, mottled extremities (excessive vasoconstriction).
Palmar, plantar, and axillary sweating.
Tremors of hands, closed eyelids, muscles of face, and lips.



THE HEART

A complete examination of the heart includes taking a history, making a physical examination, and collecting certain laboratory data.

History. If in the course of a routine examination for flying some abnormalities are found in the heart, it is then necessary to get a detailed cardiac history. The "previous" history should include questioning about such causative factors as rheumatic fever and its protean manifestations, hypertension, hyperthyroidism, syphilis, chronic pulmonary disease, or history of congenital abnormality of the heart. It is also necessary to know whether at any time there was:

1. Cardiac infection—fever, sweating, pallor, loss of weight, fatigue, and chills.
2. Cardiac insufficiency — dyspnea, orthopnea, cough, fatigue, hemoptysis, edema, cyanosis, first diminution of cardiac reserve, and number of bouts of heart failure.
3. Cardiac symptoms—coronary insufficiency, pain, and palpitation.
4. Digitalis—amount and dates, if taken.

Examination. The examination of the heart is most important in military practice since the applicant or flyer will in general minimize or deny any symptoms he may have had in the past referable to the heart. There are two parts to the examination of the heart:

Cardiac findings:

1. Inspection—location of apex beat, abnormal pulsations, precordial bulge.
2. Palpation — precordial tenderness, thrills, location of point of maximum impulse (P.M.I.) and lower and outer point (L.O.P.).
3. Percussion (of limited value).
4. Auscultation—sounds at apex and base, ventricular rate and rhythm, gallop, friction rub, murmurs.

Extracardiac findings:

1. Pulse—character, rate, rhythm, condition of arterial wall.
2. Blood pressure.
3. Evidence of congestive heart failure.
4. Condition of thyroid.
5. Chronic pulmonary disease.
6. Arteriosclerosis, retinal.
7. Clubbing of fingers and toes.

Heart sounds. A summary of normal heart sounds and of the terms to be used in describing heart sounds and murmurs are shown in the charts. In young applicants for flying training the third heart sound can be heard in about one-third. It is sometimes of such intensity as to be confused with an early diastolic murmur. These same individuals frequently show a systolic murmur at the apex; a loud systolic murmur in the pulmonic area which is heard best with the subject recumbent at the end of exhalation; and a loud, frequently split, pulmonic second sound.

All of these findings have little significance by themselves and are to be regarded as normal if the history and the laboratory and other cardiac findings are negative.

Blood pressure. The blood pressure equipment to be used, whether mercurial or anaeroid, should be in good condition and calibrated at yearly intervals. In the mercurial type the level of the mercury at rest should be exactly at the zero mark. The small air vent at the top of the glass tubing must always be patent to prevent lag in the instrument. The apparatus must be on a level surface, for tilting gives rise to errors of considerable magnitude. All valves and rubber parts should be free from leakage. The armlet for an adult should be 12 cm to 13 cm wide and

23 cm long. The cloth covering should be of inextensible material of such nature that an even pressure is exerted throughout the width of the cuff. It should extend as a band 15 cm wide for 60 cm beyond the edge of the rubber cuff, and taper gradually for an additional 30 cm. For measuring blood pressure in the leg, the rubber bag should be 15 cm wide, and its covering 17 cm wide and 120 cm long.

The patient should be comfortably seated or in a sitting position, with the arms slightly flexed and the whole forearm supported on a smooth surface or by other convenient means at the level of the heart (5 cm below the sternal angle). If readings are taken with the subject in any other position great care must be exercised to have the antecubital fossa at the level of the heart. A notation should be made of the position of the subject. The patient should be allowed time to recover from any recent exercise or excitement. The arm used should be free of constricting clothing.

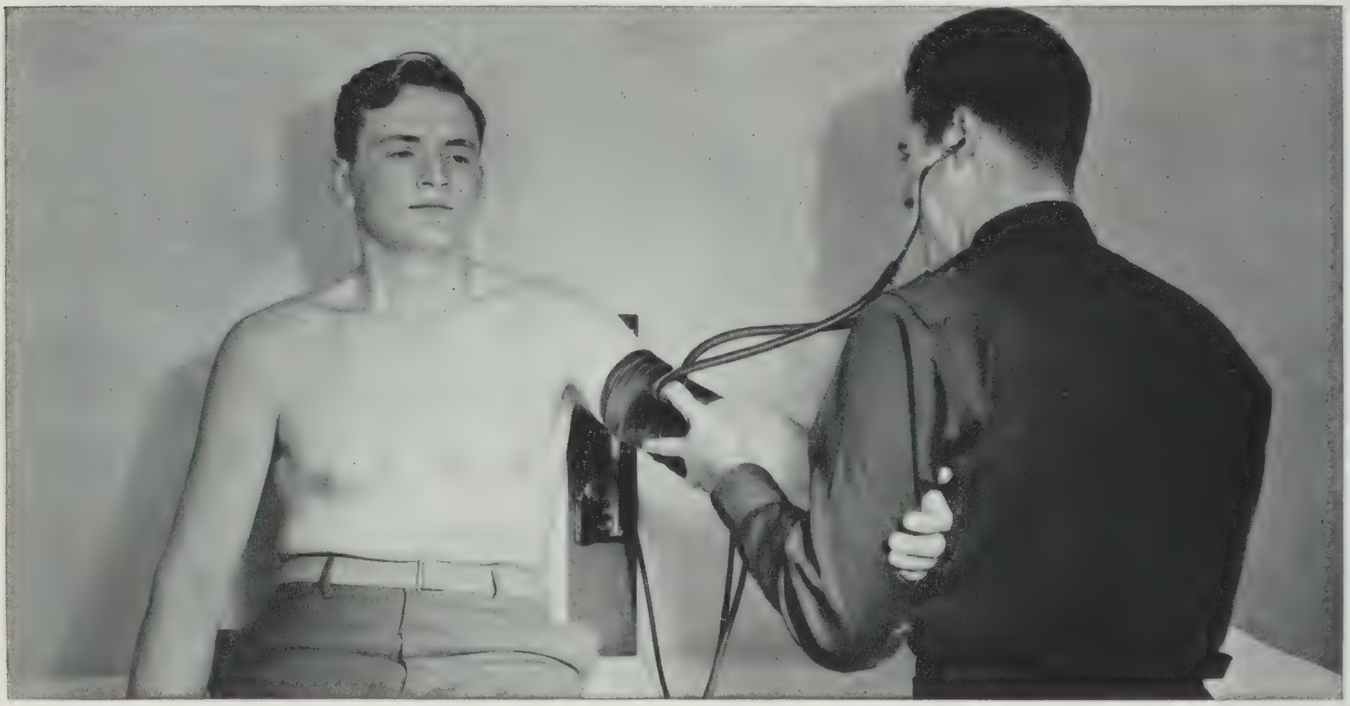
A completely deflated cuff should be applied snugly and evenly around the arm with the lower edge about 1 inch above the antecubital space, and with the rubber bag applied over the inner aspect of the arm. The cuff should be of such type and applied in such manner that inflation causes neither bulging nor displacement.

The stethoscope should be placed over the previously palpated brachial artery in the antecubital space, not in contact with the cuff, and held in place with a minimum of pressure on the skin. The hand may be pronated or supinated, depending upon which position yields the clearest brachial pulse.

In the determination of the systolic pressure only the auscultatory method is to be used. The cuff should be rapidly inflated, then slowly deflated at a rate of 2 to 3 mm of Hg. per second. The level at which the first sound regularly appears should be considered the systolic pressure.

In the determination of the diastolic pressure, with continued deflation of the cuff, the point at which the sounds suddenly become dull and muffled should be known as the diastolic pressure.

With premature beats the higher systolic pressures of the beats which terminate compensatory pauses should be ignored. With auricular fibrillation only approximations of the systolic and diastolic pressures can be made. It is recommended that systolic pressure be calculated as an average of the highest pressure at which sounds come through and the pressure at which the sound for each beat is detectable. The diastolic pressure is obtained by taking the average of several readings. With pulsus alternans both systolic pressures should be recorded. In hypertensive subjects care must be exerted to avoid errors that may be introduced by the zone of silence occasionally encountered between systolic and diastolic pressure, known as the auscultatory gap.



SUMMARY OF NORMAL HEART SOUNDS

SOUND		FIRST	SECOND	THIRD	FOURTH
Origin		From each ventricle. (1) Muscular (2) Valvular (3) Vascular (basal vessels) and (4) Auricular (see 4th heart sound) components. From both ventricles: (5) Contact with chest wall	Closure of semi-lunar valves	Vibration of ventricular walls, valves, and chordae tendineae as a result of sudden rush of blood into ventricles in early diastole	(1) Tension and contraction of auricular walls (2) Flow of blood through A-V orifices (3) Distention of ventricles (4) Friction of auricles against other structures
Components		(1) sometric phase (components 1, 2 and 5 above) (2) Ejection phase (component 3 above)	(1) Aortic (2) Pulmonic	—	Three groups resulting from: (1) Auricular contraction (2) Distention of ventricles (3) Incomplete closure of A-V valves (same as auricular component of first sound)
Auditory characteristics		(1) Prolonged (2) Low pitch (3) Variable intensity (4) Heard best at apex	(1) Short (2) High pitch (3) Variable intensity; relation of A_2 to P_2 changes with age (4) Heard best at base	(1) Short (2) Low pitch (3) Low intensity—best heard in adolescents and in youth (4) Heard best in left lateral supine position at apex	(1) Each group short (2) Lowest pitch (3) Usually inaudible (recorded best in mesocardiac area. Heard in this area in A-V block).
Graphic relations	E.K.G.	Just after peak of R (auricular component precedes peak of R wave)	End of T wave	0.14 to 0.16 sec. after end of T wave	Variable relation to P wave (0.08 to 0.30 sec. after beginning)
	Jugular Phlebogram	Before rise of C wave	0.11 sec. before peak of V wave	Lowest portion of descending limb of V wave	Usually after the rise of the A wave
	Carotid Arteriogram	.04 to .10 sec. before rise of carotid pulse	Incisura (dicrotic notch)	0.14 to 0.16 sec. after incisura	—
Physiologic variations due to	Cardiac factors	(1) Rate of rise of intraventricular pressure (2) Duration of P-R interval	(1) Relative intra-aortic and intra-pulmonic pressures (2) Differences in pressure between chamber and vessels	Suddenness of ventricular filling	Increased venous return to the heart
	Extra cardiac factors	Common to all. Variations in intensity due to variations in thickness of thoracic wall, shape of chest, size of lungs, etc.			

TERMS TO BE USED IN DESCRIBING HEART SOUNDS AND MURMURS

*(Terms in Capitals Preferred)**

HEART SOUNDS

INTENSITY	PITCH	QUALITY	DURATION	TIME
NORMAL	HIGH	NORMAL	NORMAL	
FAINT		SHARP	SHORT	
Weak		Snapping		
Distant		Valvular		
Muffled				
LOUD	LOW	BOOMING	PROLONGED	
Accentuated		Muscular		
Increased				
ABSENT		SPLIT		
Replaced		RINGING		
by a murmur		Metallic		
		Bell-like		
		Tambour		
		Hollow		

MURMURS

INTENSITY	PITCH	QUALITY	DURATION	TIME
FAINT	HIGH	BLOWING	SHORT	SYSTOLIC
Soft				
MODERATE	MEDIUM	HARSH	MODERATE	EARLY SYSTOLIC
		Rough		
		Coarse		
LOUD	LOW	MUSICAL	LONG	LATE SYSTOLIC
		RUMBLING		DIASTOLIC
		CRESCENDO		EARLY DIASTOLIC
		DECRESCENDO		MID-DIASTOLIC
				PRESYSTOLIC
				(Late Diastolic)

*From Nomenclature and Criteria for Diagnosis of Diseases of the Heart, 4th edition, 1939.

THE ELECTROCARDIOGRAM

1. Standard leads:

The normal electrocardiogram consists of a group of summits and depressions. There may be as many as 7 of these (P, Ta, Q, R, S, T, and U), but the P, R, and T are normally always present.

The P wave and Ta wave comprise the auricular complex. The ventricular complex consists of initial (QRS) and final (RS–T and T) deflections.

"Auricular Complex." The P wave results from electrical excitation or depolarization of the auricular muscle. In the normal it is upright in leads I and II and is not more than 0.25 or less than 0.05 millivolt in height. Its width at its base is 0.1 second or less. It is rounded or pointed and often notched. The electrocardiogram is said to display a *high voltage P wave* if this deflection is more than 0.25 mv. in any standard lead, and a *low voltage P wave* if this deflection is less than 0.05 mv. in all three standard leads.

The Ta wave is a gradual depression occurring immediately after the P wave which usually is slight and rarely exceeds 0.1 mv. It represents electrical recovery or repolarization of the auricular muscle.

"Ventricular Complex." The initial ventricular deflections, Q, R, and S, are written during electrical excitation or depolarization of the ventricular muscle.

The Q wave may be normally absent. It is an initial downward ventricular deflection which is neither slurred nor splintered and which has a maximum absolute and relative size in the three leads as follows:

These criteria are not applicable in any lead to curves showing a high voltage of QRS, or in leads II and III if there is right deviation of the electrical axis.

A normal R wave is an upward deflection varying in size from 0.15 to 2.0 mv. It is not unusually slurred, notched, or splintered.

A normal S wave is a depression preceded by a summit. It does not exceed 0.6 mv. in depth, and is not unusually slurred, splintered, or notched.

When any QRS deflection in the 3 leads, measured in either direction from the baseline, exceeds 2.0 mv., the electrocardiogram is said to show high voltage of QRS or simply *high voltage*. When the largest QRS deflection is less than 0.5 mv., similarly measured, the curve is said to show *low voltage*.

The *final ventricular deflections*, S-T and T, are written during electrical recovery or repolarization of the ventricular muscle.

The normal *S-T (R-T, RS-T) segment* is that portion of the curve between the end of QRS and the beginning of T. It is not normally displaced at its origin by more than 0.1 mv. in either direction from the baseline. It usually inclines upward slightly as it approaches the T wave.

The normal T wave is upright in leads I and II. Occasionally it may be inverted in leads II and III, especially in hyposthenic subjects when sitting, but becomes upright in lead II or in leads II and III when the electrocardiogram is recorded with the subject recumbent.

Lead	Absolute size in millivolts	Percent of largest QRS deflection in the three leads
I	0.20	15%
II	0.25	20%
III	0.30	25%

THE NORMAL ELECTROCARDIOGRAM

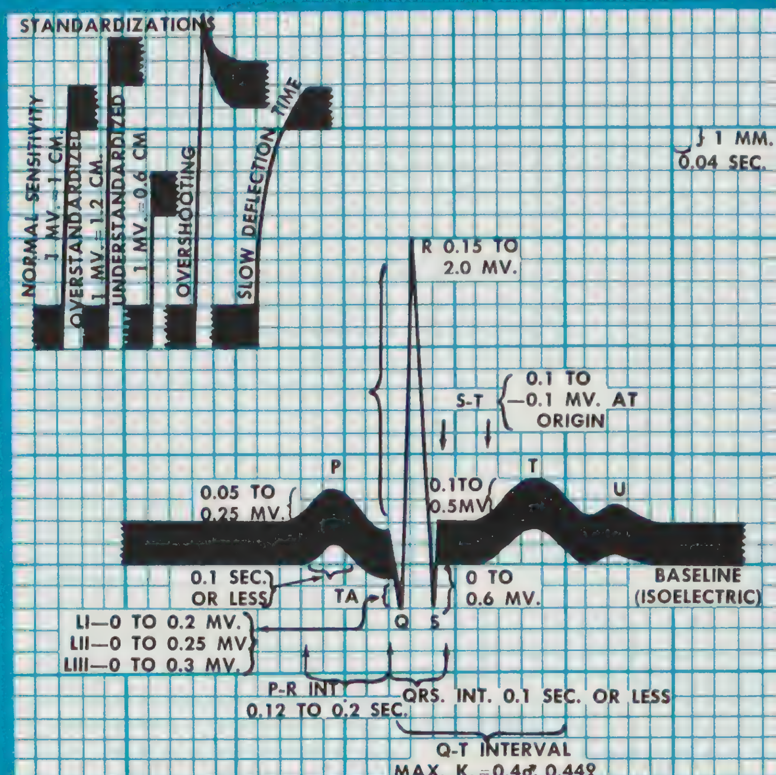


Table for calculating rate and the systolic index (Q—T/√R—R) in the electrocardiogram. R—R is the cycle length or the distance between 2 R waves.

R — R in 0.04 Sec.	Rate per Minute	√R — R in Sec.	R — R in 0.04 Sec.	Rate per Minute	√R — R in Sec.
10.00	150	0.633	20.50	73	0.906
10.50	143	0.648	21.00	71	0.917
11.00	136	0.663	21.50	70	0.927
11.50	130	0.678	22.00	68	0.938
12.00	125	0.693	22.50	67	0.949
12.50	120	0.707	23.00	65	0.959
13.00	115	0.721	23.50	64	0.970
13.50	111	0.735	24.00	62	0.980
14.00	107	0.748	24.50	61	0.990
14.50	103	0.762	25.00	60	1.000
15.00	100	0.775	25.50	59	1.010
15.50	97	0.787	26.00	58	1.020
16.00	94	0.800	26.50	57	1.030
16.50	91	0.812	27.00	56	1.039
17.00	88	0.825	27.50	55	1.049
17.50	86	0.837	28.00	54	1.058
18.00	83	0.849	28.50	53	1.068
18.50	81	0.860	29.00	52	1.077
19.00	79	0.872	29.50	51	1.086
19.50	77	0.883	30.00	50	1.095
20.00	75	0.894			

The normal T wave varies in size from 0.1 to 0.5 mv. The electrocardiogram is said to show a *high voltage T wave* if this deflection is more than 0.5 mv. in any standard lead, and a *low voltage T wave* if this deflection is less than 0.1 mv. in the three standard leads.

The U wave is a small deflection which occurs inconstantly after the T wave. It is normally upright.

"Intervals." The *P-R (P-Q) interval* is measured from the beginning of the P wave to the beginning of QRS. Its normal value is 0.12 to 0.20 sec. in adults. It is an index of auriculoventricular conduction. It normally gets shorter as the rate gets faster.

The *QRS interval* is measured from the beginning to the end of QRS. It represents the duration of excitation of the ventricular muscle. In adults it is normally 0.1 sec. or less.

The *Q-T Interval* is measured from the beginning of QRS to the end of the T wave. It normally gets shorter as the heart rate gets faster. A correction for rate is expressed in the systolic index, K, which is the Q-T interval in seconds divided by the square root of the cycle length ($K = Q\text{-}T\sqrt{R-R}$). In normal subjects K has a maximum value of 0.4 in males, and 0.44 in females.

2. Precordial leads:

Technique. Lead IVF is the chest lead to be used in military examinations. The exploring electrode should be circular, less than 3 cm in diameter, and placed at the outer border of the apex of the heart as determined by palpation. If the apex beat cannot be located satisfactorily, the electrode may be placed in the fifth intercostal space just lateral to the left midclavicular line.

The indifferent electrode is placed on the left leg.

Galvanometer connections are made in such a way that relative positivity of the exploring or apical electrode is represented by an upward deflection in the finished record. One method by which this can be done is to connect the left leg wire to the exploring electrode and the left arm wire to the left leg. The lead switch is turned to lead III.

The sensitivity of the recording device should be so adjusted that a potential difference of one millivolt causes deflection of one centimeter as in the standard leads. Any reduction in sensitivity made necessary by very large deflections should be clearly indicated on the curve, preferably by photographing the standardization.

Criteria. Tentatively, the following values in tenths of a millivolt (millimeters at normal sensitivity of the string) may be used for the range of normal deflections in normal male subjects:

	P	*Q*	*R*	*S*	*T*	*S-T*
Min.	—1.0	.0	3.0	1.0	0.5	—0.5
Max.	1.5	3.0	30.0	35.0	13.0	2.0

CARDIAC RADIOGRAPHY

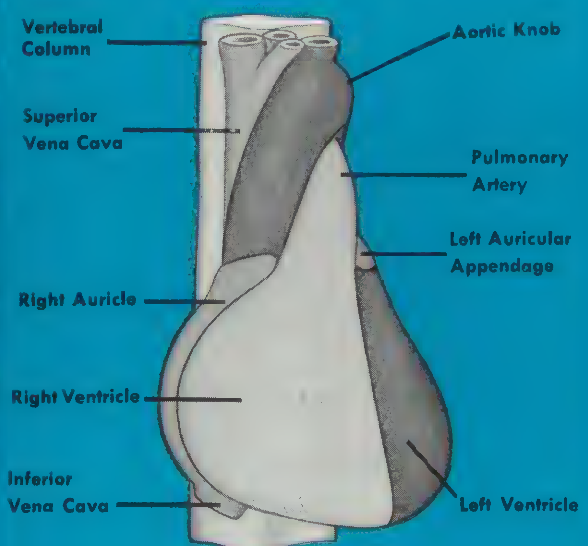
The principal methods of examining the heart radiographically are fluoroscopy, teleroentgenography, orthodiagraphy, kymoroentgenography, and angiography. In general, the fluoroscopic method is the best because good oblique views may be obtained, the degree of motion of separate chambers and vessels may be observed, and minor degrees of enlargement not ordinarily manifested in the usual measurements may be detected.

The usual measurements made on the cardiac silhouette of a teleroentgenogram (2 meter plate) or on an orthodiagram are shown in the figure. If the "area" of the cardiac shadow is desired, it is measured first by completing its superior and inferior borders, by conjecture, and then by determining the area of the ovoid thus formed with a planimeter.

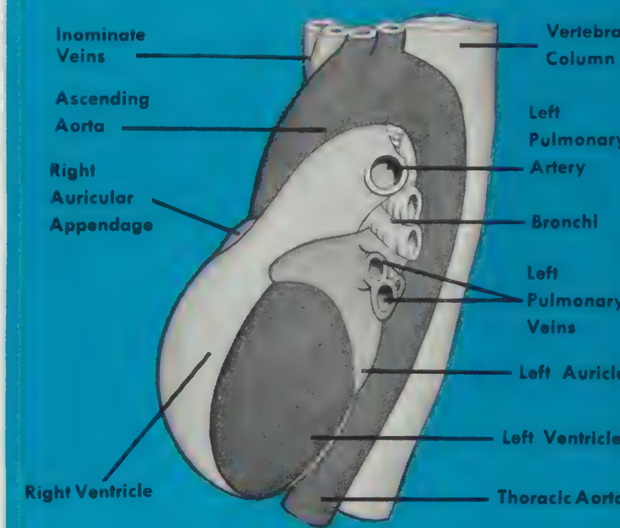
The transverse diameter is the most widely used measurement. When calculated on the *teleroentgenogram,* it may be compared to the predicted normal for the height and weight of that individual, determined on radiographs made in mid-inspiration. A deviation of 10% from this prediction is likely to be abnormal. In making the normal table, the authors measured the heights of their subjects with shoes on, and the weights included all clothing except coat and vest. Corrections must be made for this, because heights and weights in the army are determined with the subject completely unclothed.

When the transverse diameter is measured on an *orthodiagram* made during quiet respiration, a different prediction table must be used. The prediction from this table is based on height, weight, age, and sex. A deviation of more than 1 cm from this prediction is regarded as abnormal. The normal cardiac area on the orthodiagram can also be predicted.

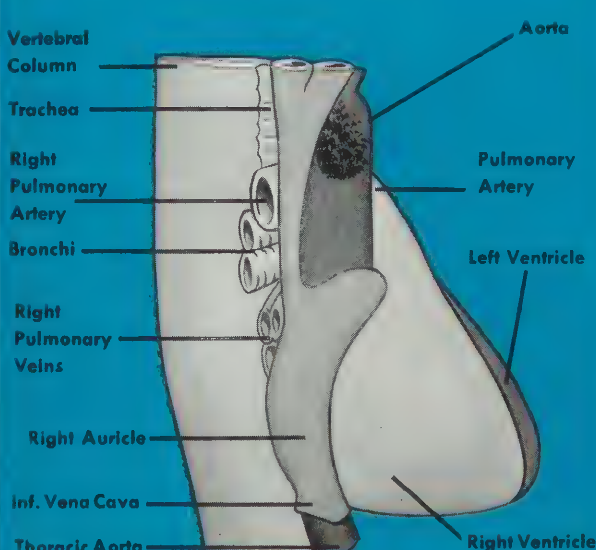
The width of the aorta can be measured in several ways, the most common being the one in which the greatest distances between the midline and the lateral borders of the shadow of this vessel on either side are summated. In male adults this measurement normally does not exceed 7 cm.



Antero-Posterior

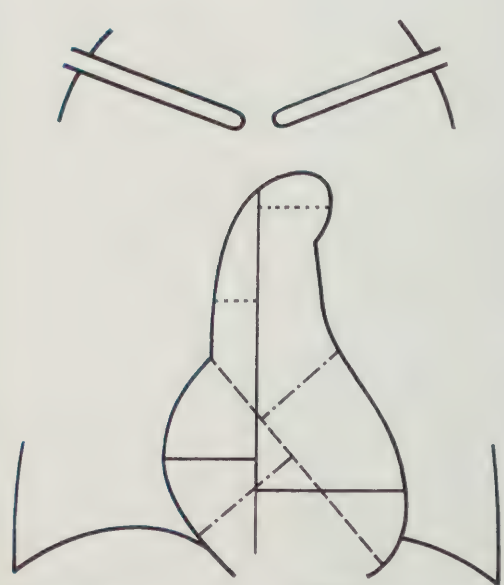


Left Anterior Oblique



Right Anterior Oblique

MEASUREMENTS OF THE HEART ON THE RADIOGRAPH



Transverse Diameter ________

Long (Oblique) Diameter — — —

Broad Diameter — - — - —

Aortic Width - - - - - - -

Theoretical Transverse Diameters of Heart Silhouette on Teleoroentgenogram for Various Heights and Weights

T. D. of Heart	HEIGHT 5'0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	6'0"	1"	2"	3"	4"	5"	6"
100 mm	83	85	86	87	89	90	92												
101 “	85	86	88	89	91	92	93	95											
102 “	87	88	90	91	92	94	95	97											
103 “	88	90	92	93	94	96	97	99	100										
104 “	90	92	93	95	96	98	99	101	102										
105 “	92	93	95	96	98	99	101	103	104	106									
106 “	94	95	97	98	100	101	103	104	106	108									
107 “	95	97	99	100	102	103	105	106	108	110	111								
108 “	97	99	100	102	104	105	107	108	110	112	113								
109 “	99	101	102	104	106	107	109	110	112	114	115	117							
110 “	101	102	104	106	108	109	111	113	114	116	118	119	121						
111 “	103	104	106	108	109	111	113	115	116	118	120	121	123	125					
112 “	105	106	108	110	111	113	115	117	118	120	122	124	125	127	129				
113 “	106	108	110	112	113	115	117	119	121	123	124	126	128	129	131	133			
114 “	108	110	112	114	115	117	119	121	123	125	126	128	130	132	133	135	137		
115 “	110	112	114	116	117	119	121	123	125	127	129	130	132	134	136	138	140	141	
116 “	112	114	116	118	120	121	123	125	127	129	131	133	134	136	138	140	142	144	146
117 “	114	116	118	120	122	124	125	127	129	131	133	135	137	139	141	143	144	146	148
118 “	116	118	120	122	124	126	128	129	131	133	135	137	139	141	143	145	147	149	151
119 “	118	120	122	124	126	128	130	132	134	136	138	140	142	143	145	147	149	151	153
120 “	120	122	124	126	128	130	132	134	136	138	140	142	144	146	148	150	152	154	156
121 “	122	124	126	128	130	132	134	136	138	140	142	144	146	148	150	152	154	156	159
122 “	124	126	128	130	132	134	136	138	140	143	145	147	149	151	153	155	157	159	161
123 “	126	128	130	132	134	136	139	141	143	145	147	149	151	153	155	157	160	162	164
124 “	128	130	132	134	137	139	141	143	145	147	149	152	154	156	158	160	162	164	166
125 “	130	132	134	137	139	141	143	145	147	150	152	154	156	158	160	163	165	167	169
126 “	132	134	137	139	141	143	145	148	150	152	154	156	159	161	163	165	167	170	172
127 “	134	137	139	141	143	146	148	150	152	154	157	159	161	163	166	168	170	172	175
128 “	136	139	141	143	146	148	150	152	155	157	159	161	164	166	168	171	173	175	177
129 “	139	141	143	146	148	150	152	155	157	159	162	164	166	169	171	173	176	178	180
130 “	141	143	145	148	150	152	155	157	160	162	164	167	169	171	174	176	178	181	183
131 “	143	145	148	150	152	155	157	160	162	164	167	169	172	174	176	179	181	183	186
132 “	145	148	150	152	155	157	160	162	164	167	169	172	174	177	179	181	184	186	189
133 “	147	150	152	155	157	160	162	165	167	169	172	174	177	179	182	184	187	189	192
134 “	150	152	155	157	160	162	164	167	169	172	174	177	179	182	184	187	189	192	194
135 “	152	154	157	159	162	164	167	169	172	175	177	180	182	185	187	190	192	195	197
136 “	154	157	159	162	164	167	169	172	175	177	180	182	185	187	190	193	195	198	200
137 “	156	159	162	164	167	169	172	175	177	180	182	185	188	190	193	195	198	201	203
138 “	159	161	164	167	169	172	174	177	180	182	185	188	190	193	196	198	201	204	206
139 “	161	164	166	169	172	174	177	180	182	185	188	190	193	196	198	201	204	206	209
140 “	163	166	169	171	174	177	180	182	185	188	190	193	196	199	201	204	207	209	212
141 “	166	168	171	174	177	179	182	185	188	190	193	196	199	201	204	207	210	212	215
142 “	168	171	174	176	179	182	185	188	190	193	196	199	202	204	207	210	213	216	218
143 “	170	173	176	179	182	184	187	190	193	196	199	202	204	207	210	213	216	219	221
144 “	173	176	178	181	184	187	190	193	196	199	201	204	207	210	213	216	219	222	224
145 “	175	178	181	184	187	190	193	196	198	201	204	207	210	213	216	219	222	225	228
146 “	178	180	183	186	189	192	195	198	201	204	207	210	213	216	219	222	225	228	231
147 “	180	183	186	189	192	195	198	201	204	207	210	213	216	219	222	225	228	231	234
148 “	182	185	188	192	195	198	201	204	207	210	213	216	219	222	225	228	231	234	237
149 “	185	188	191	194	197	200	203	206	210	213	216	219	222	225	228	231	234	237	240
150 “	187	191	194	197	200	203	206	209	212	215	219	222	225	228	231	234	237	240	243
151 “	190	193	196	199	203	206	209	212	215	218	222	225	228	231	234	237	241	244	247
152 “	192	196	199	202	205	208	212	215	218	221	224	228	231	234	237	241	244	247	250
153 “	195	198	201	205	208	211	214	218	221	224	227	231	234	237	240	244	247	250	253
154 “	198	201	204	207	211	214	217	221	224	227	230	234	237	240	244	247	250	253	257
155 “	200	203	207	210	213	217	220	224	227	230	233	237	240	243	247	250	253	257	260
156 “		206	210	213	216	220	223	227	230	233	236	240	243	247	250	254	257	260	264
157 “				216	219	222	226	229	233	236	239	243	246	250	253	257	260	263	267
158 “						225	229	232	236	239	243	246	249	253	256	260	263	267	270
159 “								235	239	242	246	249	253	256	260	263	267	270	274
160 “										145	249	252	256	259	263	266	270	274	277
161 “												255	259	263	266	270	273	277	281
162 “												259	262	266	270	273	277	280	284
163 “														269	273	277	280	284	288
164 “														273	276	280	284	287	291

Refer to paper entitled "A Study of the Transverse Diameter of the Heart Silhouette with Prediction Table Based on the Teleoroentgenogram" presented to the Association of Life Insurance Medical Directors of America by Dr. Harry E. Ungerleider of the Equitable Life Assurance Society, and Dr. Charles P. Clark, of the Mutual Benefit Life Insurance Company. (1938)

Table for Determining the Per Cent. Deviation from Average

Minus 25%	20%	15%	10%	5%	Av. %	Plus 5%	10%	15%	20%	25%
75	80	85	90	95	100	105	110	115	120	125
76	81	86	91	96	101	106	111	116	121	126
77	82	87	92	97	102	107	112	117	122	128
77	82	88	93	98	103	108	113	118	124	129
78	83	88	94	99	104	109	114	120	125	130
79	84	89	95	100	105	110	116	121	126	131
80	85	90	95	101	106	111	117	122	127	133
80	86	91	96	102	107	112	118	123	128	134
81	86	92	97	103	108	113	119	124	130	135
82	87	93	98	104	109	114	120	125	131	136
83	88	94	99	105	110	116	121	127	132	138
83	89	94	100	105	111	117	122	128	133	139
84	90	95	101	106	112	118	123	129	134	140
85	90	96	102	107	113	119	124	130	136	141
86	91	97	103	108	114	120	125	131	137	143
86	92	98	104	109	115	121	127	132	138	144
87	93	99	104	110	116	122	128	133	139	145
88	94	99	105	111	117	123	129	135	140	146
89	94	100	106	112	118	124	130	136	142	148
89	95	101	107	113	119	125	131	137	143	149
90	96	102	108	114	120	126	132	138	144	150
91	97	103	109	115	121	127	133	139	145	151
92	98	104	110	116	122	128	134	140	146	153
92	98	105	111	117	123	129	135	141	148	154
93	99	105	112	118	124	130	136	143	149	155
94	100	106	113	119	125	131	138	144	150	156
95	101	107	113	120	126	132	139	145	151	158
95	102	108	114	121	127	133	140	146	152	159
96	102	109	115	122	128	134	141	147	154	160
97	103	110	116	123	129	135	142	148	155	161
98	104	111	117	124	130	137	143	150	156	163
98	105	111	118	124	131	138	144	151	157	164
99	106	112	119	125	132	139	145	152	158	165
100	106	113	120	126	133	140	146	153	160	166
101	107	114	121	127	134	141	147	154	161	168
101	108	115	122	128	135	142	149	155	162	169
102	109	116	122	129	136	143	150	156	163	170
103	110	116	123	130	137	144	151	158	164	171
104	110	117	124	131	138	145	152	159	166	173
104	111	118	125	132	139	146	153	160	167	174
105	112	119	126	133	140	147	154	161	168	175
106	113	120	127	134	141	148	155	162	169	176
107	114	121	128	135	142	149	156	163	170	178
107	114	122	129	136	143	150	157	164	172	179
108	115	122	130	137	144	151	158	166	173	180
109	116	123	131	138	145	152	160	167	174	181
110	117	124	131	139	146	153	161	168	175	183
110	118	125	132	140	147	154	162	169	176	184
111	118	126	133	141	148	155	163	170	178	185
112	119	127	134	142	149	156	164	171	179	186
113	120	128	135	143	150	158	165	173	180	188
113	121	128	136	143	151	159	166	174	181	189
114	122	129	137	144	152	160	167	175	182	190
115	122	130	138	145	153	161	168	176	184	191
116	123	131	139	146	154	162	169	177	185	193
116	124	132	140	147	155	163	171	178	186	194
117	125	133	140	148	156	164	172	179	187	195
118	126	133	141	149	157	165	173	181	188	196
119	126	134	142	150	158	166	174	182	190	198
119	127	135	143	151	159	167	175	183	191	199
120	128	136	144	152	160	168	176	184	192	200
121	129	137	145	153	161	169	177	185	193	201
122	130	138	146	154	162	170	178	186	194	203
122	130	139	147	155	163	171	179	187	196	204
123	131	139	148	156	164	172	180	189	197	205

Prediction for Normal Cardiac Area and Transverse Diameter *on Orthodiagrams

Predicted T-D = $+0.1094 \times A - 0.1941 \times H + 0.8179 \times W + 95.8625$

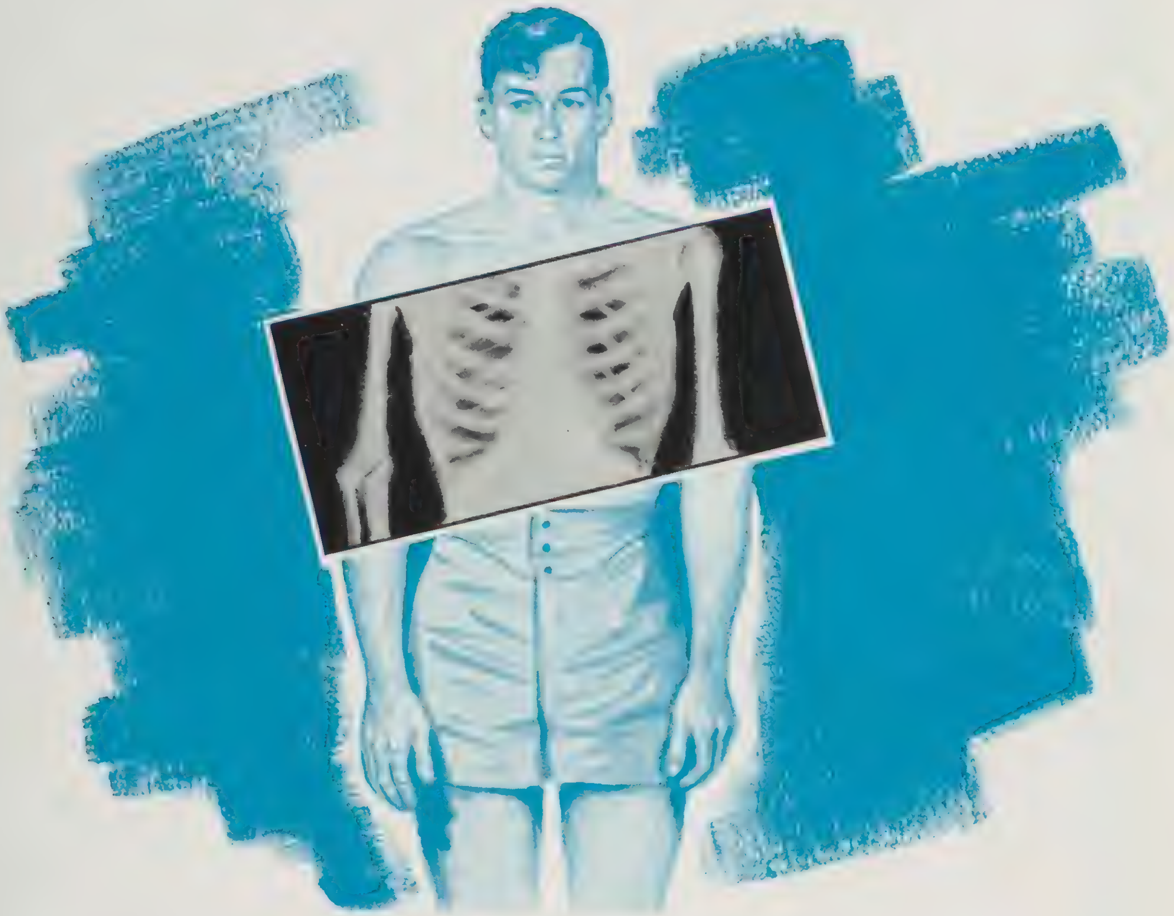
I				II			
Stature		Area, Sq. Cm.	Transverse Diameter, Mm.	Weight		Area, Sq. Cm	Transverse Diameter, Mm.
Cm.	In.			Kg.	Pounds		
150	59	66.7	66.74	50	110	17.00	40.90
151		67.57	66.55	51	112.2	17.34	41.71
152	60	68.44	66.36	52	114.4	17.68	42.53
153		69.31	66.16	53	116.6	18.02	43.35
154		70.18	65.97	54	118.8	18.36	44.17
155	61	71.05	65.77	55	121	18.70	44.98
156		71.92	65.58	56	123.2	19.04	45.80
157		72.79	65.39	57	125.4	19.38	46.62
158	62	73.66	65.19	58	127.6	19.72	47.44
159		74.53	65.00	59	129.8	20.06	48.26
160	63	75.40	64.80	60	132	20.40	49.07
161		76.27	64.61	61	134.2	20.74	49.89
162		77.14	64.42	62	136.4	21.08	50.71
163	64	78.01	64.22	63	138.6	21.42	51.53
164		78.88	64.03	64	140.8	21.76	52.35
165	65	79.75	63.83	65	143	22.10	53.16
166		80.62	63.64	66	145.2	22.44	53.98
167		81.49	63.45	67	147.4	22.78	54.80
168	66	82.36	63.25	68	149.6	23.12	55.62
169		83.23	63.06	69	151.8	23.46	56.44
170	67	84.10	62.86	70	154	23.80	57.25
171		84.97	62.67	71	156.2	24.14	58.07
172		85.84	62.47	72	158.4	24.48	58.89
173	68	86.71	62.28	73	160.6	24.82	59.71
174		87.58	62.09	74	162.8	25.16	60.52
175	69	88.45	61.89	75	165	25.50	61.34
176		89.32	61.70	76	167.2	25.84	62.16
177		90.19	61.50	77	169.4	26.18	62.98
178	70	91.06	61.31	78	171.6	26.52	63.80
179		91.93	61.12	79	173.8	26.86	64.61
180	71	92.80	60.92	80	176	27.20	65.43
181		93.67	60.73	81	178.2	27.54	66.25
182		94.54	60.53	82	180.4	27.88	67.07
183	72	95.41	60.34	83	182.6	28.22	67.89
184		96.28	60.15	84	184.8	28.56	68.70
185	73	97.15	59.95	85	187	28.90	69.52
186		98.02	59.76	86	189.2	29.24	70.34
187		98.89	59.56	87	191.4	29.58	71.16
188	74	99.76	59.37	88	193.6	29.92	71.98
189		100.63	59.18	89	195.8	30.26	72.79
190		101.50	58.98	90	198	30.60	73.61
191	75	102.37	58.79	91	200.2	30.94	74.43
192		103.24	58.59	92	202.4	31.28	75.25
193	76	104.11	58.40	93	204.6	31.62	76.06
194		104.98	58.21	94	206.9	31.96	76.88
195		105.85	58.01	95	209	32.30	77.70
196	77	106.72	57.82	96	211.2	32.64	78.52
197		107.59	57.62	97	213.4	32.98	79.34
198	78	108.46	57.43	98	215.6	33.32	80.15
199		109.39	57.23	99	217.8	33.66	80.97
200	79	110.20	57.04	100	220	34.00	81.79

To find normal transverse diameter for a given individual, add T-D figure for stature to T-D figure for weight and to this total add 1 mm. for every decade of age; e. g., height, 6 feet; Weight, 187 pounds; age, 50 = 134.86 mm. T-D or 60.34 + 69.52 + 5.

*The figures of this table are valid for *orthodiagrams* and for male subjects. The hearts of female subjects of same stature, weight and age are slightly smaller in size.

From P. C. Hodges and J. A. E. Eyster: Arch. of Int. Med. 37:711,1926.

THE LUNGS



The examination of the lungs will include a consideration of the history, the physical findings, and the laboratory data.

History. If for any reason pulmonary disease is suspected in an applicant a detailed pulmonary history must be obtained. This will include interrogation regarding previous occupational exposure to irritant inhalants (inorganic, such as dust from silica, asbestos, coal, cement; and organic such as dusts from flour and cotton); recurrent or chronic respiratory diseases including asthma; previous chest taps, tuberculin tests, radiographs of chest if any; recurrent rectal abscesses or fistulae. In addition to questioning about such local symptoms as cough, sputum, dyspnea, hoarseness, and pain in the chest, constitutional symptoms such as loss of weight, lack of endurance, fatigue, fever, night sweats, and chills must be noted. Submersion, coma, general anesthesia, surgical procedure on the upper respiratory tract, or trauma to the chest may have preceded chronic disease of the lungs.

Physical examination. The procedure and abnormalities to be sought are:

1. Inspection—shape of thorax, expansion, surgical scars.
2. Palpation—tactile fremitus.
3. Percussion—hyperesonance, dullness, flatness.
4. Auscultation—breath sounds, rales.

Laboratory data. The usual laboratory data is limited to an x-ray of the chest.

Tuberculosis. This diagnosis will usually be based on roentgenographic findings. The pathogenic phase in which a given lesion presents itself should be differentiated since such knowledge is helpful in selection for military duty as well as in prognosis and treatment.

	Primary Phase	Reinfection Phase
SITE OF INITIAL LESION	A single parenchymal lesion (occasionally multiple) usually in the lower or midlung field and involvement of one or more hilar lymph nodes.	A parenchymal focus usually in upper third of the lung without gross involvement of the hilar lymph nodes.
PATHOLOGICAL LESION	Exudative pneumonic lesion proceeding to caseation, both in the pulmonary lesions and in the involved hilar nodes. Heals by fibrotic encapsulation of caseous foci with or without calification.	1. Exudative pneumonic lesion with caseation and liquefaction necrosis in center. 2. Productive pneumonic lesion—a true tubercle with a caseous center. 3. Mixed lesions of 1 and 2; usually one or the other predominates. Heals by resorption, fibrosis, and occasionally calcification.

EARLY APPEARANCE ON ROENTGENOGRAM

	Primary Phase	Reinfection Phase
	A patch of mottled or rounded homogenous clouding associated with density of enlarged hilar nodes, which cause the mediastinal border to appear wider than normal, or sometimes a localized rounded bulge is seen. In adults the enlargement of the hilar nodes is not as prominent as in chiidren.	1. Exudative—diffuse shadow of uneven density with hazy, irregular borders gradually fading into surrounding normal densities. 2. Productive—Round or irregular shadows of uniform density which are sharply delineated from surrounding normal shadows. 3. Mixed—any combination of the above.

LATE APPEARANCE OF ROENTGENOGRAM

	Primary Phase	Reinfection Phase
	May not be evident in adults, or may appear in the healed stage as a calcified pulmonary focus (Ghon tubercle) and calcified nodes. More often only the calcified nodes are visualized. *NOTE:* These apparently calcified lesions often are still partly caseous and harbor viable tubercle bacilli. Usually they remain quiescent after adolescence, but large lesions or those not uniformly calcified are potential sources of future disease.	1. Exudative—changes more rapid, definite and extensive. Excavation denoted by rarefaction within the shadows of the various infiltrations. 2. Productive—same changes may occur but are likely to be less rapid and less extensive. 3. Mixed—changes depend on which type is predominant. Healing of all types is indicated by gradual fading of shadows about the periphery. Fibrosis often appears as stellate densities radiating from the central round lesions or as wiry streaklike sharply defined lines radiating in a fanlike manner from the hilum toward the periphery.

A quantitative classification (National Tuberculosis Association) of pulmonary tuberculosis is as follows:

1. Minimal. Slight lesions without demonstrable excavation confined to a small part of one or both lungs. The total extent of the lesions, regardless of distribution, shall not exceed the equivalent of the volume of lung tissue which lies above the second chondrosternal junction and the spine of the fourth or body of the fifth thoracic vertebra on one side.

NOTE: Early and minimal tuberculosis are not synonymous terms. Early tuberculosis may be extensive, and minimal tuberculosis may be of long duration.

2. Moderately advanced. One or both lungs may be involved, but the total extent of the lesions shall not exceed the following limits: (a) Slight disseminated lesions which may extend through not more than the volume of one lung, or the equivalent of this in both lungs. (b) Dense and confluent lesions which may extend through not more than the equivalent of one-third the volume of one lung. (c) Any gradation within the above limits. (d) Total diameter of cavities, if present, estimated not to exceed 4 cm.

3. Far advanced. Lesions more extensive than moderately advanced.

Procedure in Reading a Thoracic Roentgenogram

Interpretation of an x-ray of the chest consists of evaluating the correctness of the technique used in recording, of the technical quality of the plate, and finally of examining various structures in a precise order.

1. Technique employed (TM 8-240).

a. Posture—scapula out of pulmonary field.

b. Phase of respiration—note blurring due to movements of ribs, diaphragm, heart or blood vessels.

c. Proper centering of x-ray tube—improper centering or rotation of patient projects image of mediastimum to one side. With proper centering the spinous processes of the upper thoracic vertebrae should be in a vertical line which falls midway between sternal ends of the clavicles.

2. Technical quality (TM 8-240).

a. Artefacts.

b. Overpenetration. Small pulmonary lesions not seen.

c. Underpenetration. General fogginess, no contrast in details.

3. Order of examination.

a. Density of soft tissues—breast, nipple shadows, neck, etc.

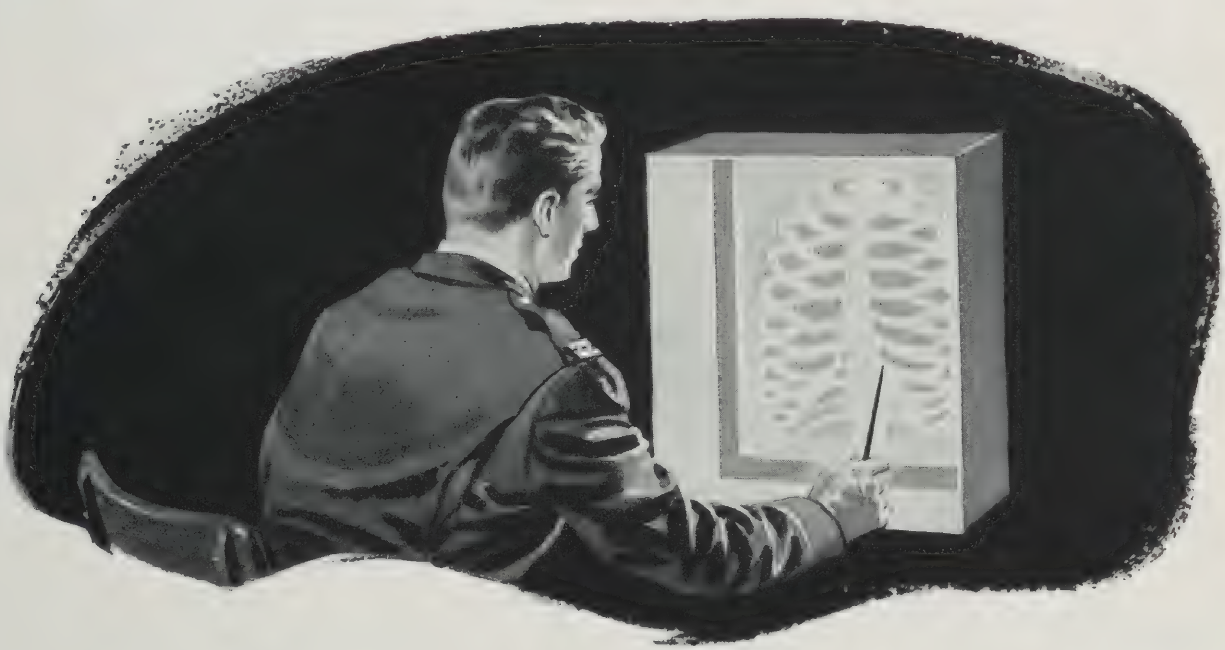
b. Bony frame work—ribs, clavicles, size of intercostal spaces, vertebrae.

c. Trachea—position, course and size.

d. Cardiovascular silhouette.

e. Diaphragm and costophrenic sinuses—position, contour, adhesions.

f. Lung fields—hilar and truncal shadows; pulmonary parenchyma.

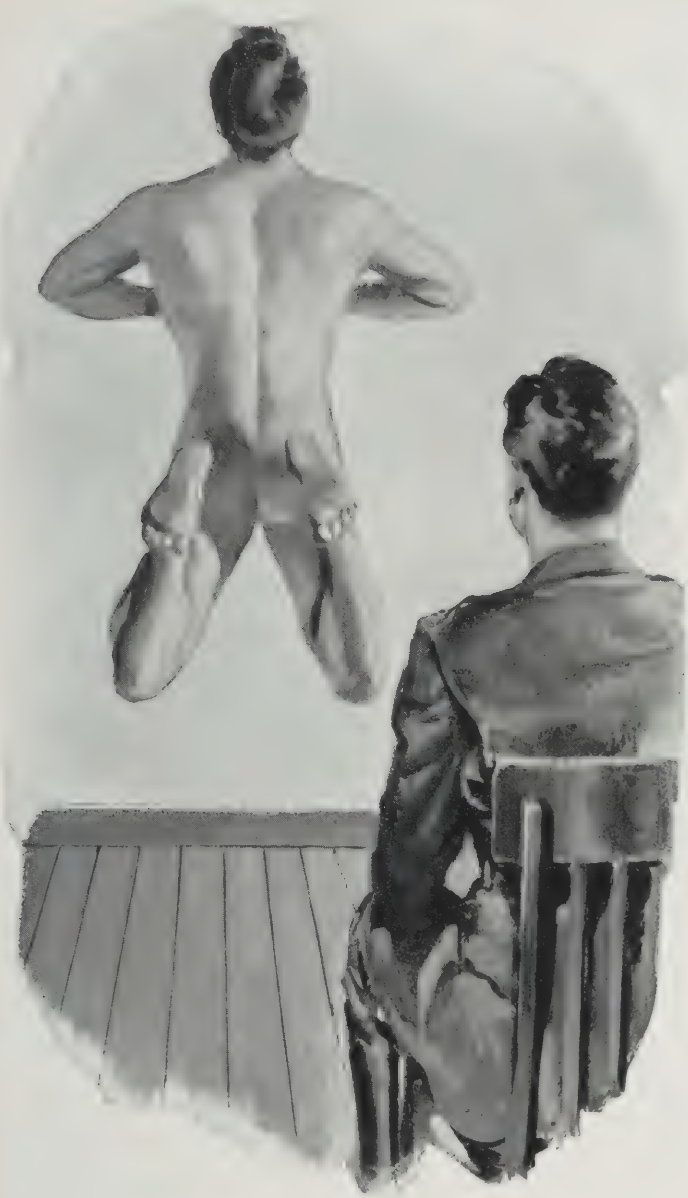


BONES, JOINTS, MUSCLES, AND FEET

Exercises. The applicant will be put through a series of movements which will bring into action the various joints and muscles of the body. The examiner should give the commands for these exercises in concise, easily understandable language but should not demonstrate them to the applicant. This enables the flight surgeon to evaluate the applicant's intelligence.

The elbows should be brought firmly to the sides of the body and the forearms extended to the front, palms of the hands uppermost; extend and flex each finger separately; bring the tips of the thumbs to the base of the little fingers; close the hands, with the thumbs covering the fingers; extend and flex the hands on the wrists; rotate the hands so that the finger nails will first be up and then down; move the hands from side to side. Extend the arms and forearms fully to the front and rotate them at the shoulders; flex the forearms on the arms sharply, striking the shoulders with the fists. Extend the arms at right angles to the body; place the thumbs on the points of the shoulders; raise and lower the arms, bringing them sharply to the sides at each motion. Let the arms hang loosely by the sides; swing the right arm in a circle rapidly from the shoulder, first to the front and then to the rear; swing the left arm in the same manner. Extend the arms fully to the front, keeping the palms of the hands together and the thumbs up; carry the arms quickly back as far as possible, keeping the thumbs up, and at the same time raise the body on the toes. Extend the arms above the head, locking the thumbs, and bend over to touch the ground with the hands, keeping the knees straight.

Extend one leg, lifting the heel from the floor, and move all the toes freely; move the foot up and down and from side to side, bending the ankle joint, and knee being kept rigid; bend the knee freely; kick forcibly backward and forward; throw the leg out to the side as far as possible, keeping the body squarely to the front; repeat all these movements with the other foot and leg; strike the breast first with one knee and then with the other; stand upon the toes of



both feet; squat sharply several times; kneel upon both knees at the same time (if the man comes down on one knee after the other there is reason to suspect infirmity).

Take the position of "fire kneeling"; stand erect, present the back to the examiner, and then hold up to view the sole of each foot; leap directly up striking the buttocks with both heels at the same time; hop the length of the room on the ball of first one foot and then the other; make a standing jump as far as possible and repeat it several times; run the length of the room several times.

Pes planus. Changes in the arches of the foot may be marked but if they have occurred slowly they may cause no symptoms. A slight change rapidly evolved may, on the other hand, cause acute symptoms.

1. Classification. It has been customary in accordance with AR 40-100 to describe pes planus as being first, second, or third degree depending upon the extent of the anatomical deformity. By usage *first degree* pes planus has come to mean lowering of the longitudinal arch; *second degree* means that in addition to the lowered arch there is a beginning bulge of the medial border with some bowing of the tendon of Achilles; and *third degree* indicates complete disappearance of the longitudinal arch, inward rotation of the astragalus with bulging of the inner border, bowing of Achilles tendon, abduction, and variable degrees of rigidity. This amount of deformity, especially lowering of the longitudinal arch, does not necessarily parallel the severity of the symptoms, and weakness of the foot may be marked when there is slight or no deformity.

2. Examination. The examination should include inspection for:

a. Lowering of the longitudinal arch.
b. Bowing of Achilles tendon.
c. Abduction.
d. Weakness of the feet on exercise.
e. Spasticity and rigidity determined by manipulation.
f. The line of weight bearing.
g. Bulging of the medial aspect of the foot.
h. Callosities.

3. History. The most common symptoms of weak foot are aching principally along the medial border of the foot, with variable degrees of stiffness, aching in the calf, and symptoms of low back strain. In general these symptoms are brought on or exaggerated by use of the foot.

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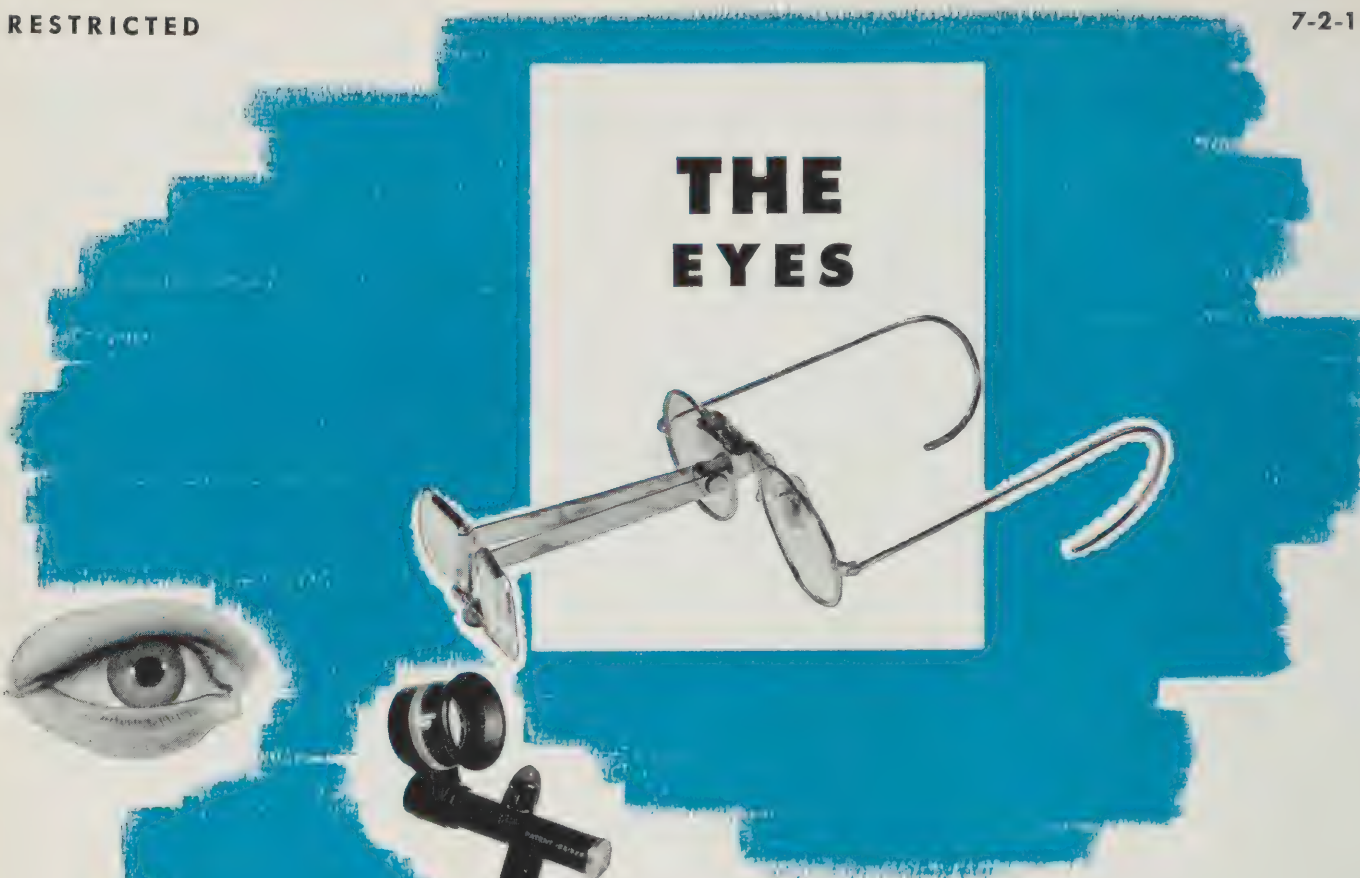
THE EYES



INSPECTION

Equipment. Binocular loupe, magnifying lens (from the trial case), ophthalmoscope, hand slit lamp, slit lamp microscope.

Technique. Where magnification is desirable, the examiner wears a binocular loupe, employs an ophthalmoscope with a plus 20 diopter lens in the aperture, uses a magnifying lens from the trial case, or examines the subject with a hand slit lamp or slit lamp microscope. The lids, eyelashes, bulbar and palpebral conjunctiva, conjunctival fornices, cornea, and iris are examined. An attempt is made to express secretion from the puncta by compression of the lacrimal sacs.

Common errors.

1. Failure to evert the upper lids.
2. Inadequate illumination of the eyes.

Nystagmus. The examinee's eyes in forward gaze, are inspected for oscillatory movements. The patient's gaze is then directed to the extreme right and left limits, and movements of each eye are noted.

The physiological nystagmus which develops in extreme positions of normal fixation is of no significance and is to be disregarded.

PRIMARY DIFFERENTIAL DIAGNOSTIC POINTS IN NYSTAGMUS

	Visual Acuity	Slow and quick component	Occurs only in extreme positions	Occurs in any position	Accompanied by vertigo, nausea, vomiting, past pointing, etc.
Physiological	Not diagnostic	No	Yes	No	No
Ocular Nystagmus	Much impaired central vision	No	No	When attempting to see objects	No
Nystagmoid movements due to extraocular muscle paralysis	Not diagnostic	As a rule	Only in extreme position in field of action of paralyzed muscle	No	No
Central Nystagmus (lesion of C.N.S.)	Not diagnostic	As a rule, but not always	No	Yes	Not as a rule
Labyrinthine nystagmus	Not diagnostic	Yes	No	Yes	Yes

OCULAR TENSION

Technique

1. By palpation. The examinee is instructed to keep both eyes open and to look down. With the third and fourth fingers of each hand placed on the examinee's brow, the examiner places the tips of his index fingers upon the eyelid, 1 to 1.5 cm above the lid margin. The examiner makes light pressure on each eye with each finger in turn, estimating the freedom of fluctuation of the globe. Ocular tension is roughly estimated as normal, increased or decreased.

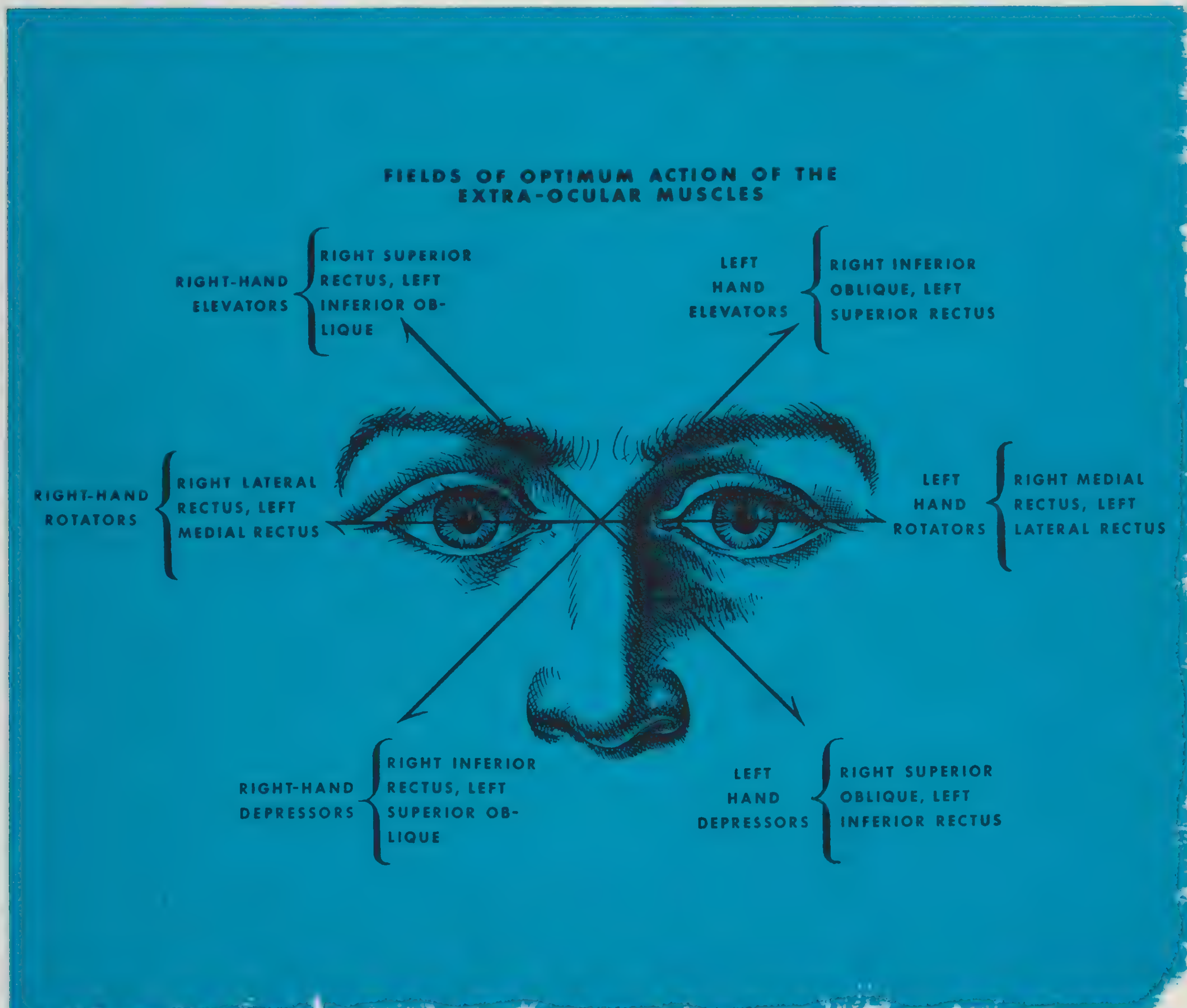
2. By tonometer. A tonometric determination, as described in standard texts, gives a quantitative measure of ocular tension when needed.

ASSOCIATED PARALLEL MOVEMENTS

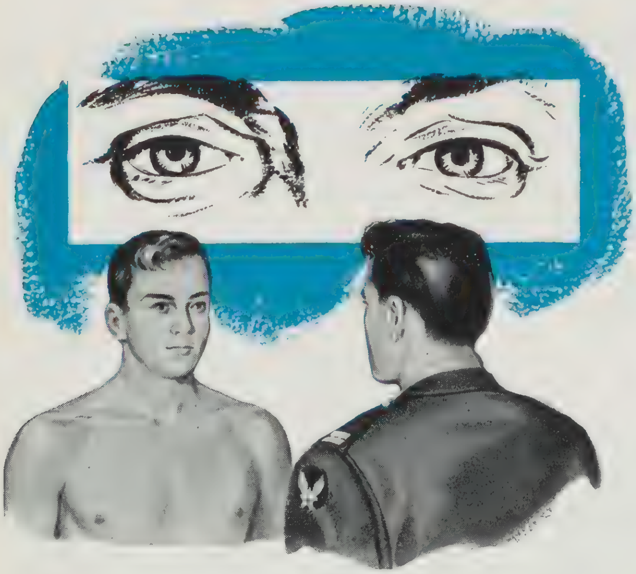
Technique. A pencil point or other target is held directly before the examinee's face and he is instructed to fix his gaze upon it. The relative position of the eyes and any deviation from binocular fixation are observed. From this primary position, the target is carried peripherally in each of the cardinal directions, the examiner noting whether the eyes are able to maintain binocular fixation in all directions of gaze.

Interpretation of findings. Inability of the eyes to maintain binocular fixation in all directions of gaze suggests extraocular muscle paresis. Although the diagnosis of ocular palsies is difficult, the affected muscle or muscles may be detected by reference to the diagram which illustrates the fields of optimum primary action of the 12 extraocular muscles of the two eyes.

Precautions. Deviations from the normal in this examination should be confirmed with the red lens test. Determination of fixation fields may also be of value.



PUPILLARY EXAMINATION



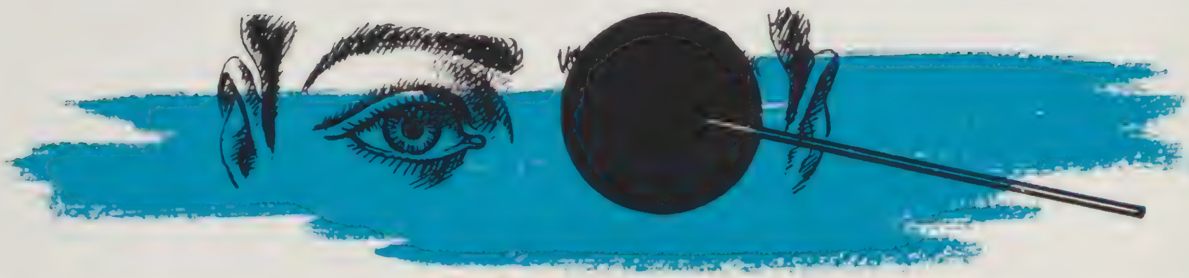
Technique.

1. Equality of pupils. The shape of the pupil of each eye is observed and the size of the two pupils is compared.

2. Reaction to light. The examinee faces a bright source of light and both eyes are shielded with cardboards held 1 inch before the eyes. The right eye is uncovered. Stimulation by light will normally cause the right pupil to contract (direct reaction to light); simultaneously, the left pupil contracts and to an equal degree (concensual reaction to light). The test is repeated, uncovering the left eye.

3. Reaction to accommodation. A distant point (on the far wall of the examining room or outside a window) is selected. A small target, e.g., a pencil point, is held before the examinee's face and in line with his eyes and the distant target. The examinee is directed to look alternately at the distant and near targets; the pupils will normally constrict on transferring gaze to the near object.

THE COVER TEST



Of several possible techniques of performing this examination, only one is presented.

Equipment. Monocular occluder mounted on a handle or any small cardboard screen.

Technique and interpretation. With the examinee's face adequately illuminated, he is directed to fix his gaze on an object at least 20 feet distant. The eyes are closely observed and any deviation of the visual axes from parallelism is noted. The further procedure depends upon the presence or absence of observed manifest deviation of the eyes in binocular fixation.

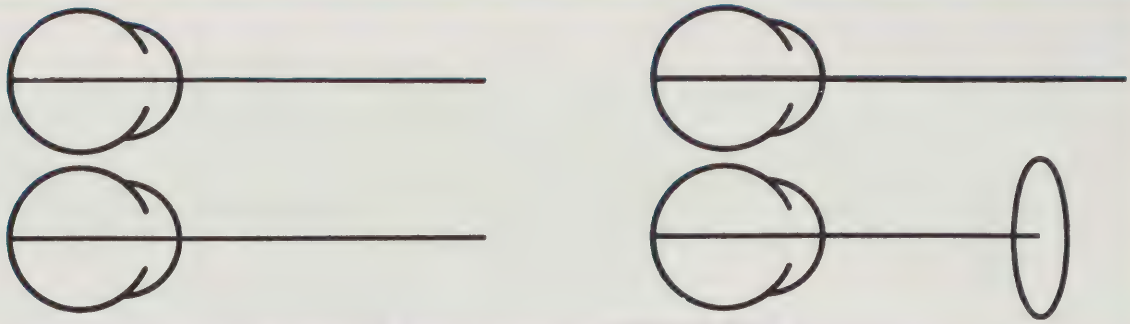
1. No manifest deviation (orthophoria or heterophoria). The occluder is held before the right eye but at such a distance that observation of the eye is permitted. The examiner notes any movement of the right eye upon occlusion, both as to direction and degree. The occluder is removed and any movement of the right eye as it recovers fixation is noted. The procedure is repeated with occlusion of the left eye. In *orthophoria,* no movement of either eye is observed on occlusion or release from occlusion. In the presence of heterophoria, each eye deviates when occluded, and the deviations of the two are equal. In *esophoria,* the eye moves nasally on occlusion and temporally on release from occlusion. In *exophoria,* the eye moves temporally on occlusion and nasally on release from occlusion. In right or left *hyperphoria,* the hyperphoric eye moves upward on occlusion and downward on release from occlusion. Similarly, the hypophoric eye moves downward on occlusion and upward on release from occlusion (hypophoria of one eye is considered as hyperphoria of its fellow).

2. Manifest deviation (heterotropia). Heterotropia (squint) is esotropia if the visual axes converge on looking at a distant point, exotropia if they diverge, and hypertropia if one visual axis deviates above the other. If present, squint is *constant* (one eye selected for fixation to the exclusion of the other) or *alternating* (the eyes used alternately). As a general rule, an eye which squints constantly possesses lower visual acuity than its fellow; eyes which squint alternately possess approximately equal acuity. The cover test may be used to differentiate squints of paralytic cause from concomitant, or non-paralytic cause. The degree of deviation of the squinting eye (primary deviation) is noted. The occluder is placed before the eye which, at the moment, is manifestly the squinting eye; absence of movement of this eye on occlusion confirms the diagnosis of heterotropia. The examinee is directed to look at a distant point and the occluder is placed before the non-squinting eye. The movement of this globe both as to direction and degree (secondary deviation) is observed. If, on the occlusion of each in turn, the primary and secondary deviations are equal, the heterotropia is *concomitant.* If, on the occlusion of each in turn, the secondary deviation (that is, of the non-squinting eye) is greater, the heterotropia is *paralytic.* The findings will enable the examiner to describe the type of phoria or tropia present, for example: "Orthophoria," "Esophoria," "Right Hyperphoria," "Alternating Esotropia," "Concomitant Esotropia, Right," "Paralytic Hypertropia, Left" etc.

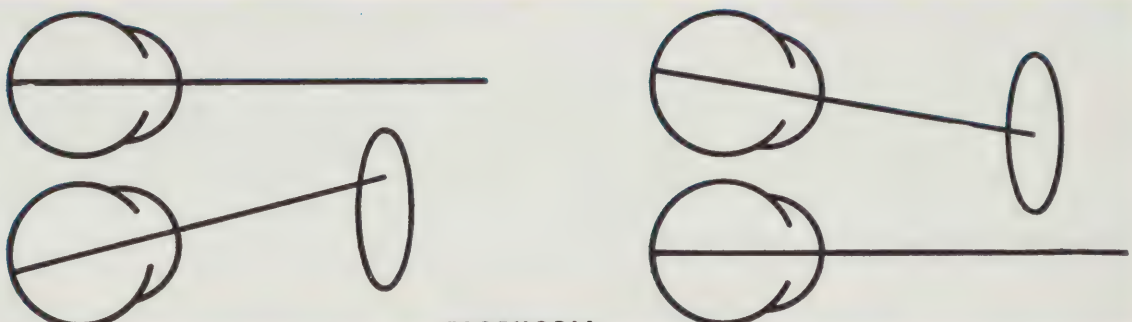
Precautions.

1. Occasionally, an examinee will present an apparent deviation of both visual axes, either outward or inward. This appearance may be due to the fact that, for anatomical reasons, the visual axes do not pass through the centers of the pupillary apertures, with the result that the corneae appear rotated temporally or nasally. That this is not a true squint is demonstrated by having the examinee look at a distant object monocularly; even with only one eye open, the eye still appears to squint. In this condition, the cover test will reveal no manifest deviation.

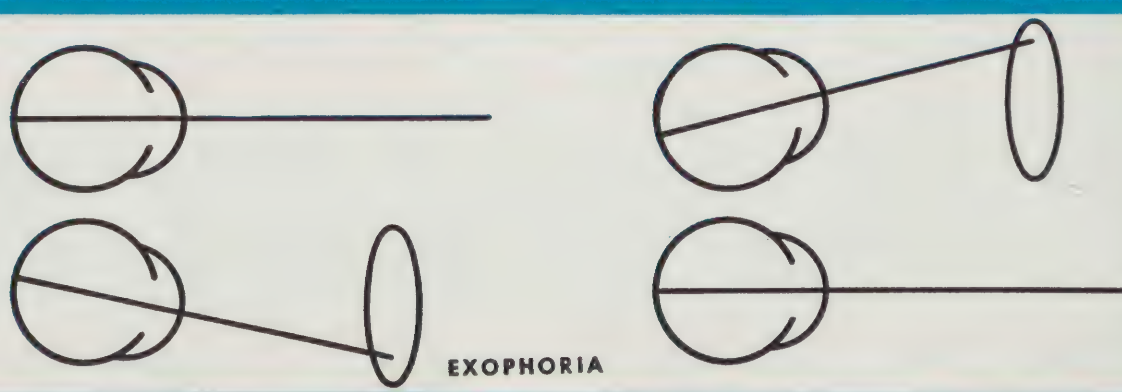
2. Heterotropia or heterophoria of less than 5 diopters is seldom disclosed by the cover test performed in the manner described above. Results of the cover test, however, should be reasonably consistent with the muscle balance as determined with the phorometer.



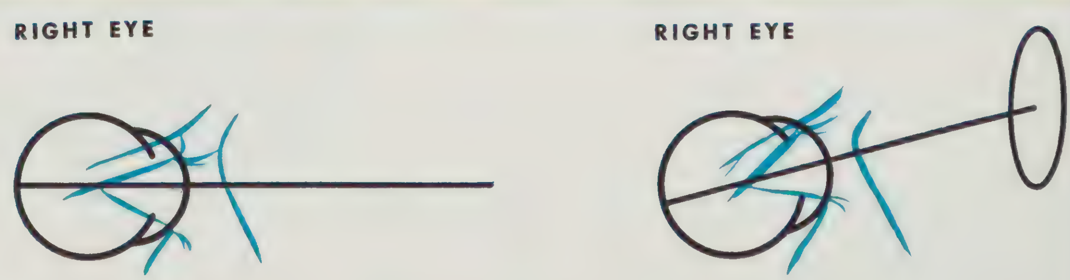
NO MANIFEST DEVIATION ORTHOPHORIA



ESOPHORIA

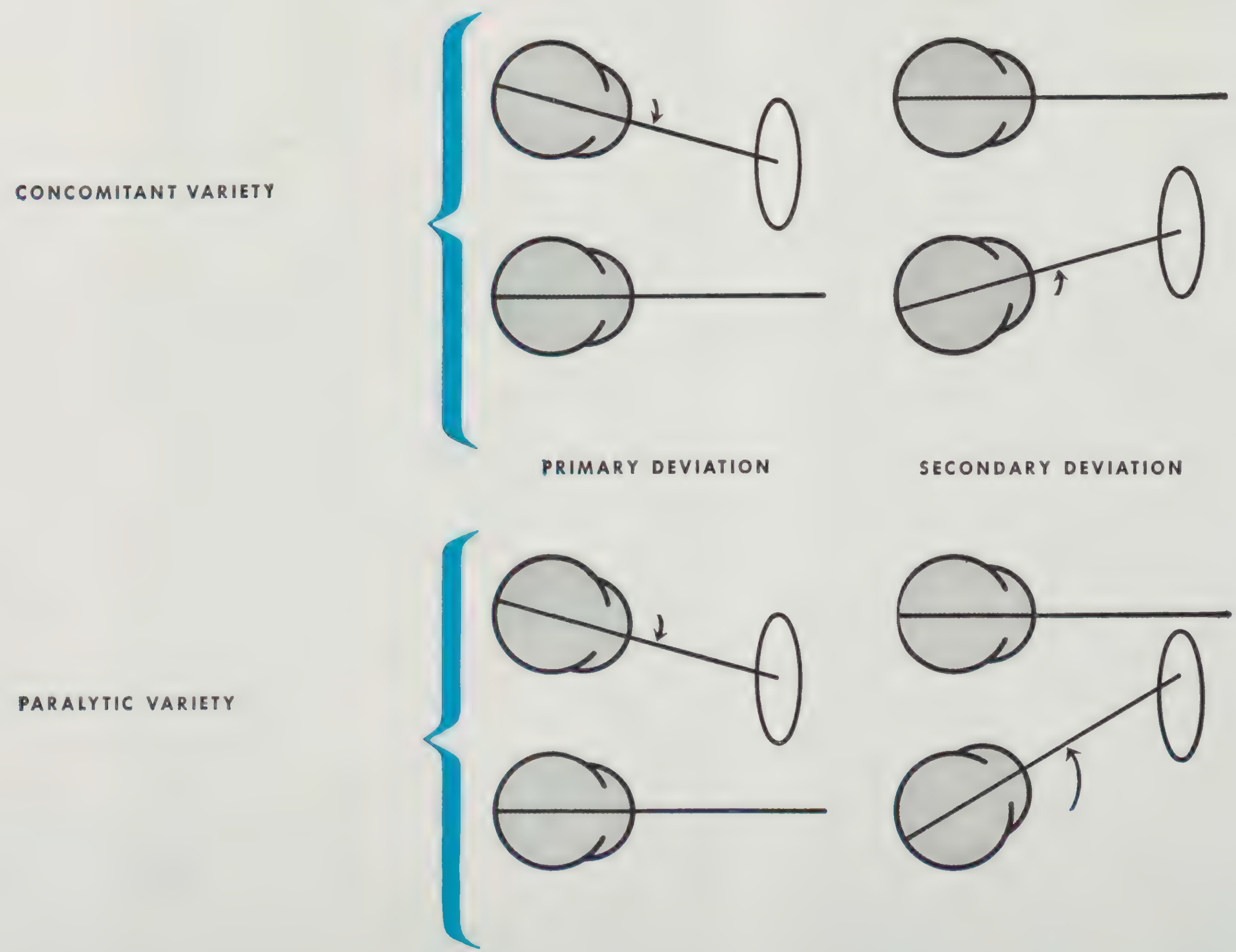


EXOPHORIA



RIGHT HYPERPHORIA

ESOTROPIA


CONCOMITANT VARIETY
PARALYTIC VARIETY
PRIMARY DEVIATION
SECONDARY DEVIATION

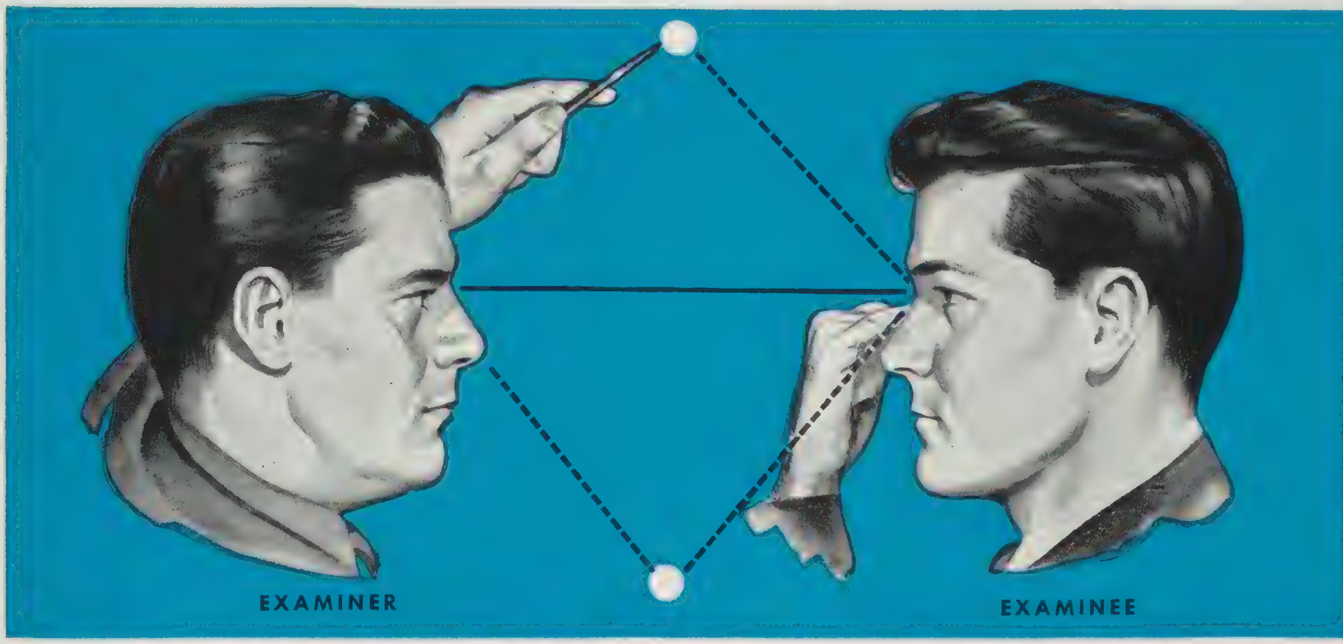
FIELD OF VISION

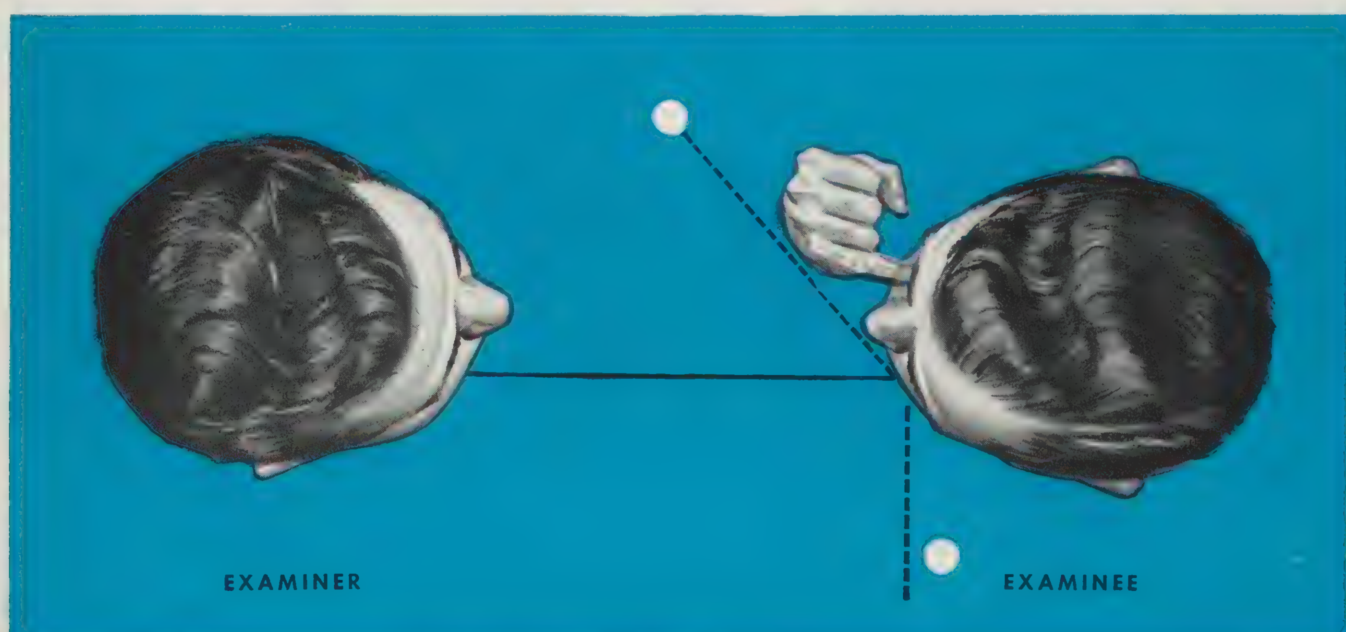
Equipment

1. For confrontation test: A one centimeter white sphere affixed to a wire 1 foot in length.
2. For complete perimetric examination: Schweigger hand perimeter or 33 cm perimeter; tangent screen or tangent rule.

Confrontation Test

Procedure. The confrontation test is routinely employed. The test is based upon a comparison of the monocular fields of vision of examiner and examinee which, assuming their facial conformations to be alike, are similar. The examiner faces the examinee





at a distance of 2 feet. The one or the other flexes his knees or rises on his toes as may be necessary in order to bring their heads into the same horizontal level. Each holds his head normally erect. The examinee closes his left eye with gentle pressure of the little finger and fixes his right eye upon the examiner's left eye. The latter closes his right eye and fixes his left upon the examinee's open eye. This fixation is continued throughout the test of the examinee's right eye. The examiner holds the white sphere overhead and in a plane midway between the two. He then carries it down, keeping his own hand out of view, until it is seen by the examinee. Assuming similar brow conformation, the examiner and the examinee should see the sphere simultaneously. The supero-temporal, super-nasal, nasal, infero-nasal, and inferior limits of the field of vision are similarly compared. To estimate the examinee's temporal and infero-temporal limits of vision, the sphere is held behind the plane of the examinee's eye and carried forward until visible; in these meridians, the visual field normally extends to 90° or more. A similar technique is used to test the left eye.

Precautions. An accurate comparison of visual fields is possible only when the examiner and the examinee are on the same eye level, hold their heads erect, and maintain proper fixation throughout the test.

Common Errors.

1. Failure to place the heads in the same horizontal plane.

2. Failure of examiner or examinee to hold his head erect.

3. Failure to accomplish monocular comparison of the visual fields; right eye with left eye, left eye with right eye.

4. Failure to examine the right eye before the left.

5. Failure to place the test object in the midplane while testing the superior, supero-temporal, supero-nasal, nasal, infero-nasal and inferior meridians.

6. Failure to place the test object behind the plane of the examinee's face while testing the temporal and infero-temporal meridians.

7. Failure to carry the test object from the non-seeing area to the area of vision.

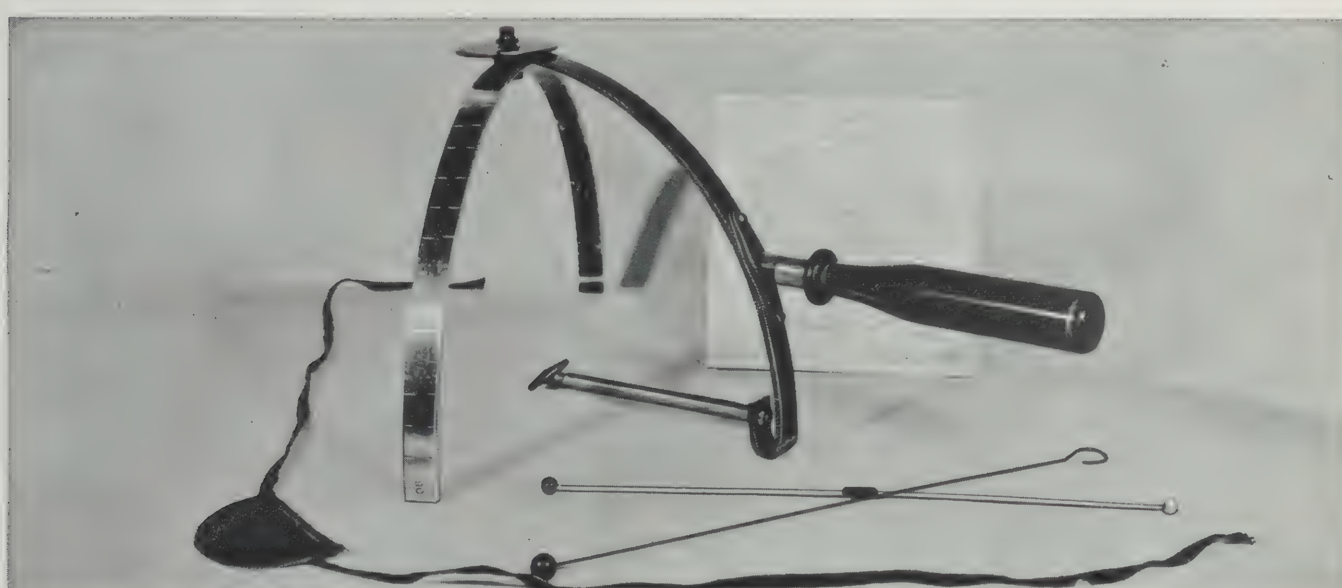
8. Too rapid movement of the test object.

9. Failure of the examiner to keep his hand peripheral to the test object.

Exact perimetric techniques

If, on the confrontation test, the field of vision appears to be constricted to a degree not attributable to prominent nose or brow, or if for any other reason the examiner suspects a visual field defect, a more exact perimetric study is made, employing the perimeter and tangent screen (TM 8-300).

Normal limits of the visual field. The normal field for form extends temporally 90° or more, super-temporally 80°, superiorly 65°, super nasally 65°, nasally 60°, infero-nasally 65°, inferiorly 75°, and infero-temporally 90° or more.



CENTRAL COLOR VISION

Equipment. The American Optical Company's compilation of pseudo-isochromatic plates, abridged edition (19 plates). If this compilation is not available, directions for the conversion of the 46 plate edition to the abridged version should be consulted. (Obtainable at AAFSAM).

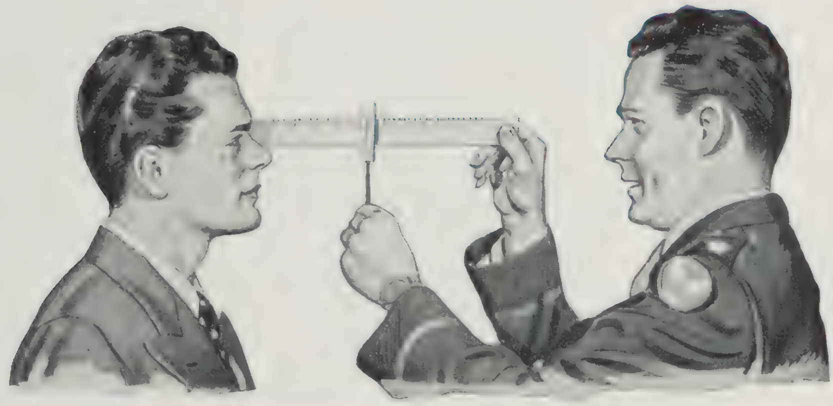
Procedure. The book is held 30 inches before the examinee's face and in a plane at right angles to his line of sight. The plates are illuminated by natural daylight (not bright sunlight) falling over the examinee's shoulder, or by "daylight" fluorescent lamps. The examinee is allowed 3 seconds to interpret each of the numbered plates. The plates are presented in any random order and notation is made of the number incorrectly interpreted. By "correct interpretation" is meant the ability to read the same number as seen by the person of average normal color perception. Some of the plates (confusion plates) bear 2 digits or pairs of digits, one of which is read by the normal, the other by the moderately color defective, and neither by the severely color blind. However, a few individuals will immediately perceive both of the digits or pairs of digits; this ability is not to be considered an incorrect interpretation. The tracing plates are traced by the applicant with a blunt pointer, but he is instructed not to touch the pointer to the surface of the paper. A correct interpretation on these plates is the ability to follow the tracing slowly but without hesitation or backtracking.

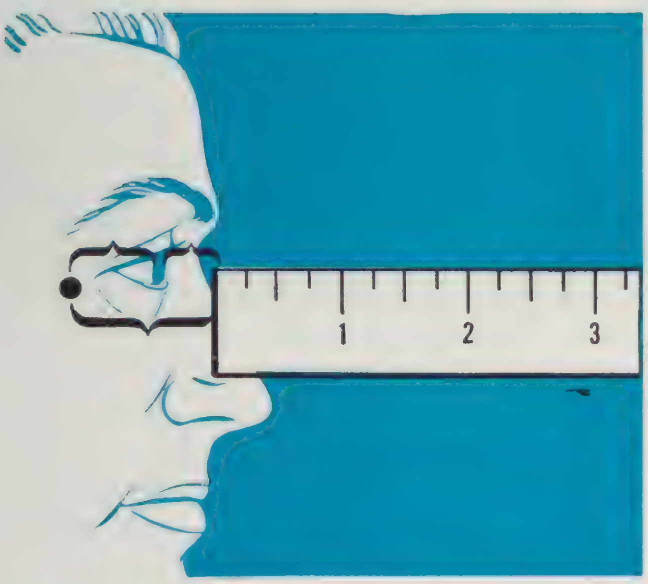
Common errors

1. Inadequate illumination of the plates.
2. Failure to hold the book perpendicular to the examinee's line of gaze.
3. Permitting the examinee to move his head from side to side in order to see the plates at an acute angle.
4. Failure to present the plates in random order.
5. Failure to present the full series of plates.
6. Failure of the examiner to keep accurate mental note of the number of incorrect interpretations.
7. Permitting the examinee to touch the surface of the plate while tracing the pathways.

Adjunctive tests of color vision. Certain individuals who fail the American Optical Company's abridged edition of pseudo-isochromatic plates will be examined by means of adjunctive color tests as prescribed by the Commanding General, AAF.

POWER OF CONVERGENCE





Equipment. The Prince rule or a rule graduated in millimeters; a pin with an enameled head, two or three millimeters in diameter, affixed to pencil-shaped wooden handle.

Procedure. Two measurements are necessary to determine the power of convergence: (a) point of convergence; (b) the pupillary distance. If the examinee habitually wears glasses or is required to wear glasses for qualification for flying, such correction is worn during the examination.

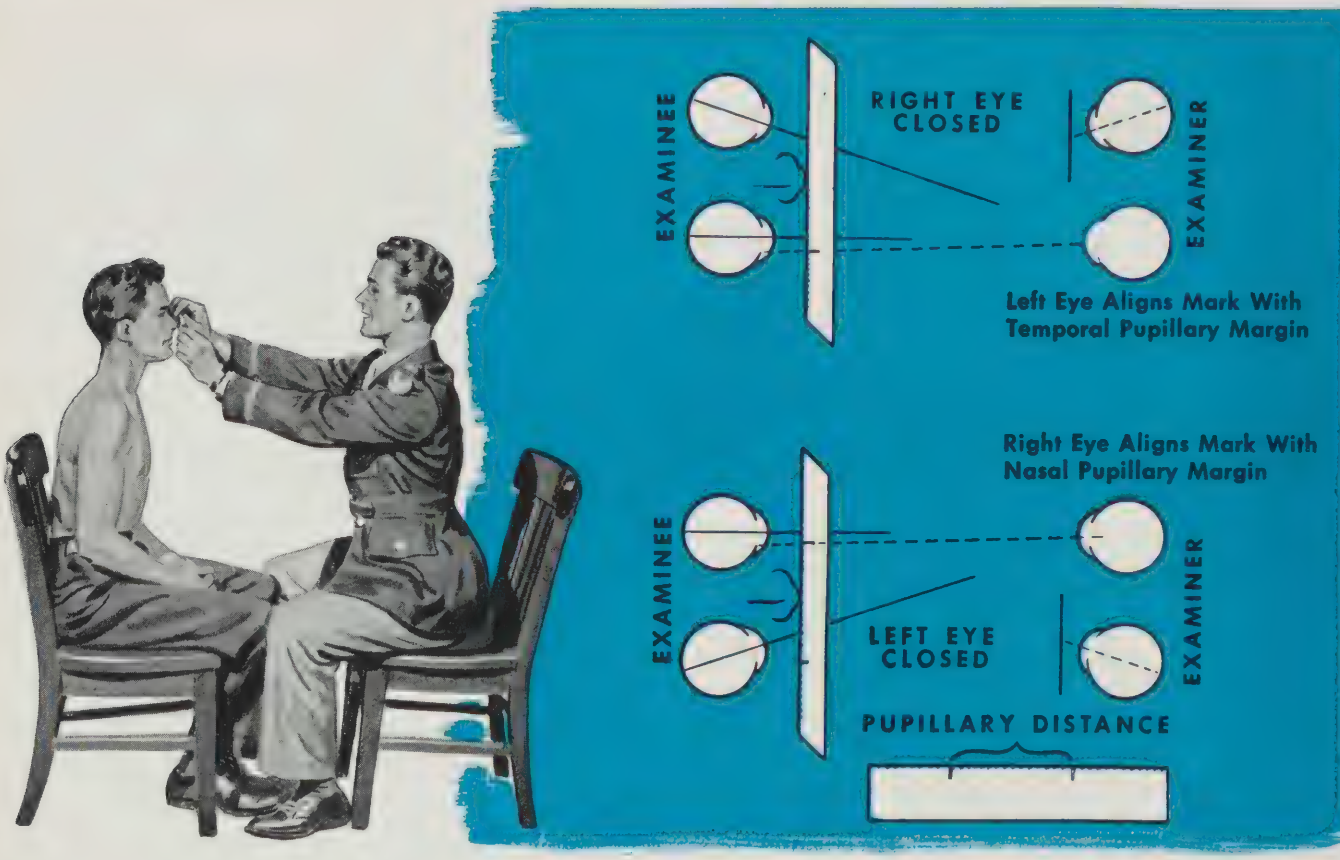
A. Estimation of the point of convergence

Technique. The examinee stands or sits with head held erect. The examiner holds the rule, edge up, with the flat surface against the right side of the examinee's nose and with the zero mark of the rule approximately 11.5 mm from the anterior surface of the cornea. The position of the rule is such that its upper edge lies approximately in the median plane between the examinee's eyes and extends horizontally before him. The examiner holds the enameled pin head above the edge of the rule and near its distal end. He instructs the examinee to fix it intently with both eyes and to report immediately the development of a diplopia. If both eyes are seen to converge upon the pin, it is then carried forward at moderate speed along the edge of the rule toward the nose. The examinee's eyes are carefully watched, and the instant one fails to converge further or swings outward, the limit of convergence is reached. The point on the rule below the pin head is the point of convergence (Pc), and is read in millimeters. The determination is repeated several times until a fairly constant reading is obtained, but this must not be carried to the point of fatiguing the examinee.

Precautions. Both eyes must converge upon the pin head at the start of the determination. The examinee's observation of the onset of diplopia is not relied upon, but to test his veracity, he is asked to state when he sees double. The pin head must at all times lie approximately at eye level and in the median line between the examinee's eyes.

Common Errors

1. Failure to place the zero mark of the rule approximately 11.5 mm before the cornea.
2. Failure to hold the rule horizontally before the eyes.
3. Too rapid or too slow movement of the pin head.
4. Lack of care in observing the "break" of the examinee's eyes.
5. Failure to keep object in median plane between eyes.



B. Estimation of the Pupillary Distance:

Technique. The examiner stands with his back to the light, and faces the examinee at arm's length. The rule is held in the examiner's two hands and is laid horizontally across the examinee's nose as close to his two eyes as possible, and with its graduated edge opposite the pupils of the eyes. The examiner may steady the rule in this position by bracing his outstretched fingers against the examinee's cheeks. The examiner closes his right eye and instructs the examinee to fix his two eyes on the examiner's open left eye. With the eyes in this position, a predetermined mark on the rule is placed in line with the temporal border of the examinee's right pupil. The rule is held steadily in this position while the examiner opens his right eye and closes his left. The examinee is then instructed to fix his two eyes upon the examiner's open right eye. The point on the rule in line with the nasal border of the examinee's left pupil is read in millimeters. The exact difference in millimeters between the predetermined mark and the latter point is the pupillary distance (Pd).

Precautions. Care is taken that each of the examinee's eyes is directed forward during the time that the position of its pupillary border is determined.

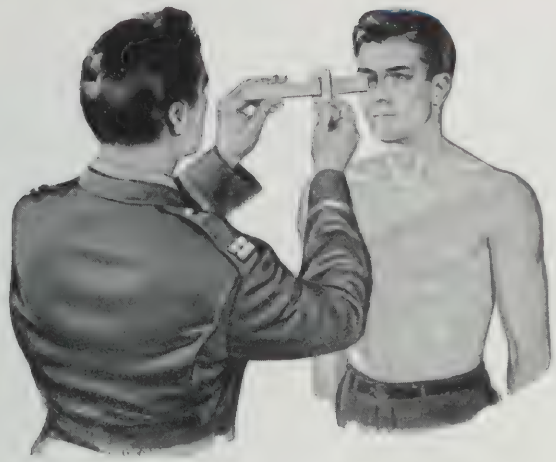
Common errors

1. Failure of the examiner to brace his rule on the examinee's face.
2. Requiring the examinee to close one eye.
3. Inadequate illumination of the examinee's eyes.
4. Failure to instruct the examinee to look at the examiner's open eye.
5. Failure of the examiner to observe the examinee's right eye with his own left eye; the examinee's left eye with his own right eye.

Evaluation of power of convergence

An examinee is considered to have normal power of convergence when the Pc does not exceed the Pd. The point of convergence (Pc) is not to be confused with the power of convergence to the base line (PcB), which was formerly estimated in AAF examinations and which exceeded the point of convergence (Pc) by 25 mm.

POWER OF ACCOMMODATION



Equipment. The Prince rule is equipped with a metal slide and a card bearing several rows of Jaeger 2 type.

Procedure. The power of accommodation is measured from the anterior focus of the eye, which is approximately 15.7 mm in front of the cornea. In measuring the accommodation of the right eye, the flat side of the Prince rule is laid against the right side of the examinee's nose with the zero mark of the rule at approximately the anterior focus. The rule is held horizontally and extending directly to the front, edge up. The card of test letters is held not more than 5 cm in front of the examinee's right eye and it is fully illuminated by light falling over his shoulder. The examinee's left eye is automatically screened from sight of the letters by the width of the rule. The examiner then carries the card of test letters slowly away from the eye and instructs the examinee to begin reading the letters aloud as soon as they become legible. The card is halted the instant he begins to read the letters correctly; if all the letters are not read correctly at this distance, the card is carried distally until they are. The point on the rule at which this is accomplished is read off in diopters. This is the measure of accommodation of the right eye. To test the left eye, the rule is changed to the left side of the nose and the above procedure is repeated, using a different line of letters. In the absence of a Prince rule, a rule graduated in centimeters may be used. A card bearing Jaeger 2 type is carried distally along the rule to the point at which it can be read without error. To arrive at the value of accommodation in diopters, divide 100 by the reading in centimeters.

Precautions. The letters on the test card are read aloud. The test card should be clean and legible. Before an examinee is disqualified for inadequate accommodative power, he is examined on 3 successive days, and the highest figure obtained is recorded.

Interpretation of findings. The adequacy of the examinee's accommodative power may be determined by reference to the table of minimum values of accommodation printed below (based upon Duane's table of mean values less 3 diopters). It is to be noted that this is a table of minimum values and differs from that previously used in AAF examinations, which was a table of mean values.

TABLE OF MINIMUM VALUES OF ACCOMMODATIVE POWER

AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS
17	8.8	24	7.2	31	5.4	38	3.4
18	8.6	25	6.9	32	5.1	39	3.1
19	8.4	26	6.7	33	4.9	40	2.8
20	8.1	27	6.5	34	4.6	41	2.4
21	7.9	28	6.2	35	4.3	42	2.0
22	7.7	29	6.0	36	4.0	43	1.5
23	7.5	30	5.7	37	3.7	44	1.0
						45	0.6

Common errors

1. Failure to instruct the examinee properly.
2. Failure to start with the right eye.
3. Failure to place the zero mark approximately 15.7 mm before the cornea.
4. Reversing the ends of the rule so that the zero mark lies distally.
5. Failure to hold the rule horizontally before the eyes.
6. Inadequate illumination of the test card.
7. Reversal of the slide on the rule.
8. Failure to place the card initially within 5 cm of the eye.
9. Failure to carry the card distally from the examinee.
10. Failure to require the reading of all the characters on the printed line.

VISUAL ACUITY AT 6 METERS

(20 FEET)

Equipment. Standard Snellen charts (of issue or commercial type), a self-illuminated test cabinet, or a satisfactory projector with screen, installed in a dark room. The Snellen chart should be illuminated by a 100-watt Mazda lamp placed four feet before and slightly above the chart, and this lamp should be so screened or shaded that no direct light from it falls upon the eyes of the examinee. The chart, cabinet, or projector screen is placed at a distance of exactly 20 feet from, and at eye-level of the examinee. When the projector is used, the projected letters must be correctly sized. This is true when the 200-foot letter measures 89 millimeters in height. The instrument must be sharply focused. A metal or cardboard occluder, equipped with handle, may be used to screen the eye not being examined. If the chart is provided with a 25-foot line, it should be obliterated.

Procedure. The examining room is darkened with the exception of the illuminated chart or screen. If the examinee wears glasses, the uncorrected acuity is determined first. The examiner occludes the examinee's left eye and directs him to read aloud and from left to right, as many of the lines of letters as possible, beginning with those of larger size, e.g., the 40-foot line, and continuing down to the smallest legible line. The left eye is then similarly examined, but with the letters of each line read in reverse order, i.e., from right to left. The smallest line of letters read correctly determines the fraction used in recording visual acuity; the numerator being 20 (distance in feet from the examinee's eyes to the chart), and the denominator being the size type of the smallest line read correctly. The number of letters read correctly in succeeding smaller lines is added to the fraction following the plus sign, e.g., "Visual acuity R.E. 20/20 + 3; L. E. 20/30 + 1." Visual acuity notations employing the minus sign are not used. Errors in a given line are offset by an equal number of correct interpretations in succeeding lines. Example: 20/40 line, no errors; 20/30 line, 2 errors; 20/20 line, 3 letters read correctly; visual acuity is 20/30 + 1.

When the examinee habitually wears corrective lenses for distant vision, the corrected acuity of each eye is similarly determined and recorded, together with the prescription for such corrective lenses.

Precautions. Examinees awaiting the visual acuity test are not permitted to remain within earshot of the examinee undergoing the test. When the examinee is suspected of having memorized the chart or projector slide, substitute charts or slides may be used, or the examiner may select or project single letters in the doubtful line, screening all others, and have the examinee name the letters exposed. The examinee is not permitted to squint, but must read with his lids normally open. The pupils are examined to exclude the possibility of the use of a miotic before examination. Bright light falling directly upon the eyes of the examinee also produces a miosis and must be avoided.

Common errors

1. Incorrect sizing of the Projectochart letters for a 20-foot examining distance.
2. Failure to focus the Projectochart letters sharply.
3. Failure to shield the examinee's eyes from extraneous light.
4. Failure to check the right eye before the left.
5. Permitting the examinee to view the chart with both eyes.
6. Failure to observe the examinee's face to detect squinting.
7. Failure of the examiner to occlude the untested eye.
8. Failure to reverse the direction in which the lines are read with right and left eyes.
9. Incorrect recording of acuity.
10. Failure to record the maximum acuity obtainable.
11. Failure to obtain the corrected acuity when the examinee wears glasses.

VISUAL ACUITY AT 50 CM

(20 INCHES)

Equipment. Jaeger or Snellen near vision test cards of commercial design. The visual equivalents of the two cards are expressed in the following table (from Parsons):

JAEGER	SNELLEN
J-1	Sn-0.5 (50 cm)
J-2	Sn-0.6 (60 cm)
J-4	Sn-0.8 (80 cm)
J-6	Sn-1.0 (1.0 m)
J-8	Sn-1.25 (1.25 m)
J-10	Sn-1.5 (1.5 m)
J-12	Sn-1.75 (1.75 m)
J-14	Sn-2.25 (2.25 m)

Procedure. The examination is conducted in a well-lighted room. The examinee is placed with his back to the source of light, either an unshaded window or artificial light. The examiner holds the card 20 inches before the eyes of the examinee and in such a position that it is uniformly illuminated. To determine the acuity of the right eye the examiner occludes the examinee's left eye and directs him to read the smallest type he can. The acuity of the left eye is determined similarly. The acuity of each eye for near distance is recorded in the Jaeger notation as "J-1-50," "J-4-50," etc.

When the examinee habitually wears corrective lenses for near or distance vision or is required to wear corrective lenses while flying for other reasons, the corrected acuity for near distance of each eye is similarly determined and recorded, together with the prescription for such glasses.

Precautions. To avoid the errors of memorization, the examinee is required to read different lines of type with the right and left eyes.

Common errors

1. Inadequate illumination of the Jaeger card.
2. Failure to hold the card 50 cm from the eye.
3. Failure to test the right eye before the left.
4. Failure of the examiner to accomplish occlusion of the untested eye himself.
5. Failure to determine corrected acuity when the examinee wears glasses.

DEPTH PERCEPTION AT 6 METERS

(20 FEET)

Equipment. The standard Howard-Dolman apparatus. The two rods, each 1 cm in diameter, are separated transversely by a distance of 64 mm. A scale affixed to the floor of the box is graduated in millimeters from 0, opposite the fixed rod, to 150 mm, before and behind the rod. The apparatus is illuminated by overhead illumination shaded from the examinee and directed against the white rear screen of the apparatus, or by suitable lighting incorporated in the apparatus. The apparatus is placed at approximately eye level with the seated examinee and at such a distance that the rear screen is 20 feet from the examinee's eyes. Care is taken that the position of the movable rod is correctly indicated on the affixed scale, and that the open aperture of the front screen faces the examinee squarely. Extraneous light is excluded.

Procedure. The examiner explains the operation of the instrument before the test is begun. The examiner stands before the seated examinee to block his view as he places the movable rod at any position widely separated from the fixed rod. The examiner steps aside, passes the cords to the examinee, and directs him to adjust the movable rod to a position beside the fixed rod, i.e., so that the two rods are equally distant from the examinee. The distance between the movable rod and the zero mark is noted. For the purpose of the record, it is immaterial whether the movable rod is placed before or behind the fixed rod. The procedure is repeated until at least 5 readings are obtained. If the readings average more than 30 mm or if the individual readings vary widely, 10 trials are given. The average error in millimeters is recorded.

If the examinee wears correcting lenses while flying, the examination is repeated with the examinee wearing his proper distance correction. The average obtained with correction is recorded as "corrected depth perception."

Precautions. The examinee is not permitted to move his head from side to side during the adjustment of the rods. The portion of the cord handled by the examinee should have no knots, frayed spots, or other points of reference which might assist him in the adjustment. Although he is permitted to pull the movable rod back and forth before his final adjustment, he is not permitted to draw the rod to either end of the box, since this procedure gives information as to the length of the box. Should the examinee waste time in the performance of the test, he is advised that prompt settings are usually more accurate than slow ones. The examiner avoids giving information, either verbally or by facial expression, as to the accuracy of successive trials until the test is completed. While the examiner is changing the position of the movable rod, he takes the cord from the examinee's hands and interrupts his view of the apparatus by standing before him.

Common Errors

1. Failure to prevent squinting or movement of the examinee's head.
2. Permitting the examinee to "run the box."
3. Failure to remove the cords from the examinee's hands between settings.
4. Informing the examinee verbally or by facial expression as to his accuracy.
5. Failure to obscure the examinee's view of the box while the rods are reset.
6. Failure to secure an adequate number of readings.
7. Failure to require additional readings (beyond 5) when the settings vary widely.
8. Recording the average settings in centimeters rather than in millimeters.
9. Failure to obtain the corrected depth perception when the patient wears glasses.

MUSCLE BALANCE AT 6 METERS
(20 FEET)
EMPLOYING THE MADDOX ROD

Equipment. A black board approximately 20 cm square with a 1 cm round hole in the center; a standard phorometer, or a half phorometer (equipped with a Maddox rod and Risley rotary prism) mounted on a suitable hand grasp; a spotlight approximately 1 centimeter in diameter (as a component of the illuminated vision test cabinet, or a muscle lamp); a suitable monocular occluder.

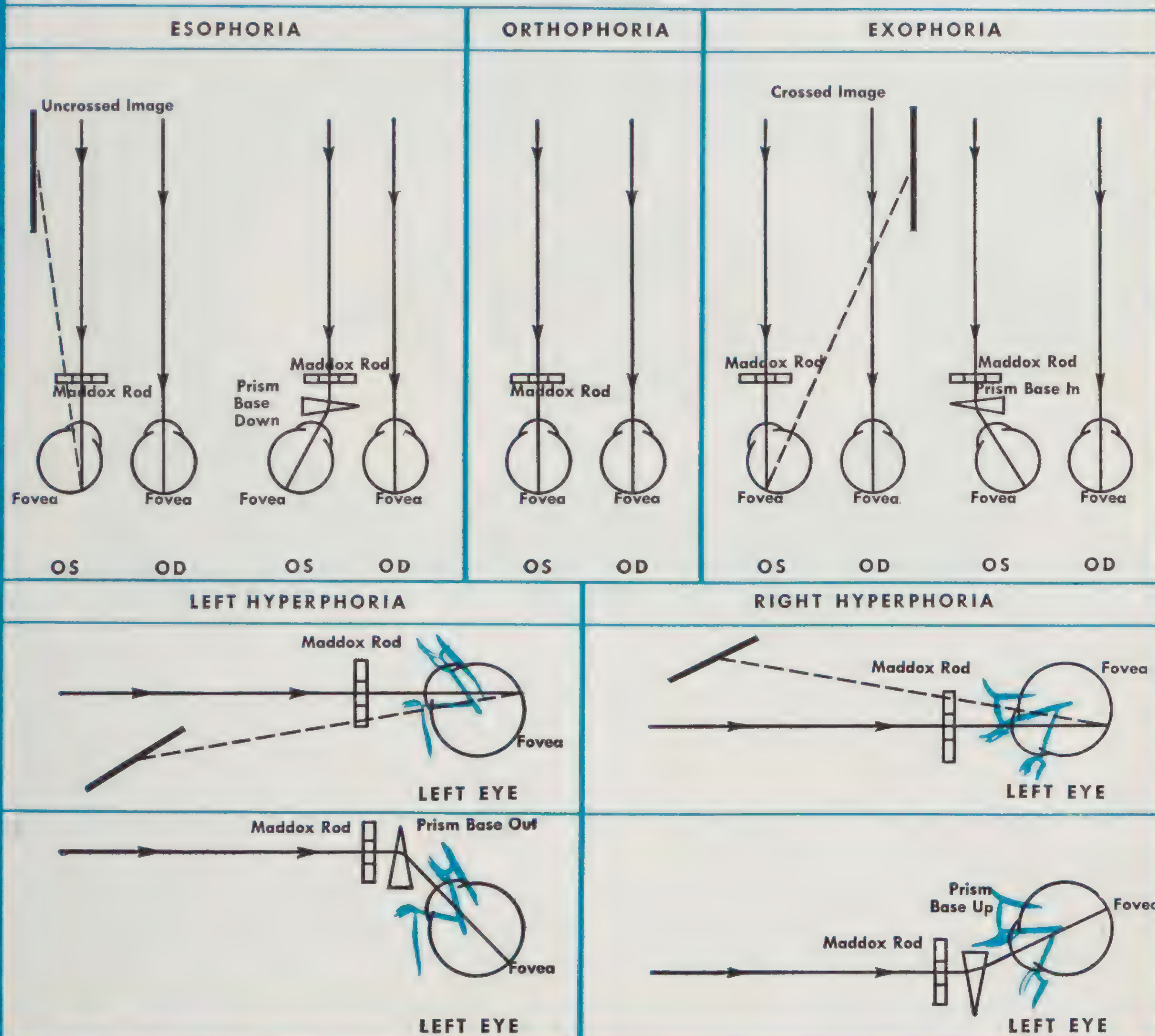
Procedure. If the examinee habitually wears corrective lenses or is required to do so to meet other requirements for flying, the test is conducted with such correction worn. The correction may contain no prismatic correction. Before beginning the test the examinee's sighting or fixing eye is determined. For this purpose a black board approximately 20 cm square with a 1 cm round hole in the center is employed. The examinee, seated, facing the spotlight 20 feet away, grasps the board with both hands. While fixing on the spotlight, he slowly raises the board at arm's length and locates the light through the hole without closing either eye. Only one eye can see the light through the hole, and by occluding the eyes alternately while the board is held steady, the eye which fixes the light can be determined. This is the sighting or fixing eye.

Having determined the sighting eye, the phorometer, if of the standard double type, is adjusted closely in front of the examinee's eyes, is leveled, and is adjusted for interpupillary distance; or if single, is held by the examinee before his non-sighting eye with his opposite hand. The multiple Maddox rod and Risley rotary prism are swung into position before the non-sighting eye. The sighting eye must have an unobstructed view of the muscle lamp. For the measurement of esophoria or exophoria, the Maddox rod is adjusted to give a vertical line of light by placing the long axis of the rod in the horizontal position. The rotary prism is adjusted for the measurement of lateral deviation; that is, with the zero mark vertical and the strength marker set 4 or 5 prism diopters off the zero mark. The occluder is moved from one eye to the other a few times to ascertain whether the examinee can see both the line and the light. If the line is not seen readily, the Maddox rod is readjusted by centering it carefully before the pupil. A multiplicity of lines seen by the examinee is due to the presence of extraneous light sources in the room, and the room must be darkened further.

When the examinee sees the line with one eye and the spot of light with the other, the examiner holds the occluder in front of the non-sighting eye to shut out the image of the line. The examinee now sees only the spot of light. After he has fixed it for several seconds, the occluder is removed for an instant and quickly replaced. In that brief interval the examinee should see the line and be able to locate it with reference to the spot of light. He is instructed to grasp the milled head that rotates the prism and turn it to shift the line directly into the spot of light. To enable him to do this the occluder is removed from the eye at intervals and quickly replaced. Finally, the examinee will have rotated the prism sufficiently to cause the line to pass through the spot of light. The number of prism diopters required to do this is read from the scale of the rotary prism. This is entered on the record as esophoria if the prism is base out (the marker displaced temporally), and as exophoria if the prism is base in (the marker displaced nasally).

For the measurement of hyperphoria, the Maddox rod before the non-sighting eye is readjusted with its long axis vertical to give a horizontal line of light. The rotary prism is readjusted to measure the vertical deviation; that is, with the zero mark temporally placed and the strength marker set 1 or 2 prism diopters off the zero mark. The occluder is used exactly as before to give an occasional glimpse of the line. The examinee rotates the milled head to cause the horizontal line to pass through the spot of light. The number of prism diopters required to do this is read from the scale of the rotary prism. This is entered on the record as right or left hyperphoria, depending upon the position of the prism. If the strength marker is below the zero mark, the prism is base down, indicating hyperphoria of that eye (i.e., the eye before which the phorometer is placed); if the strength marker is above the zero mark, the prism is base up, indicating hyperphoria of the opposite eye.

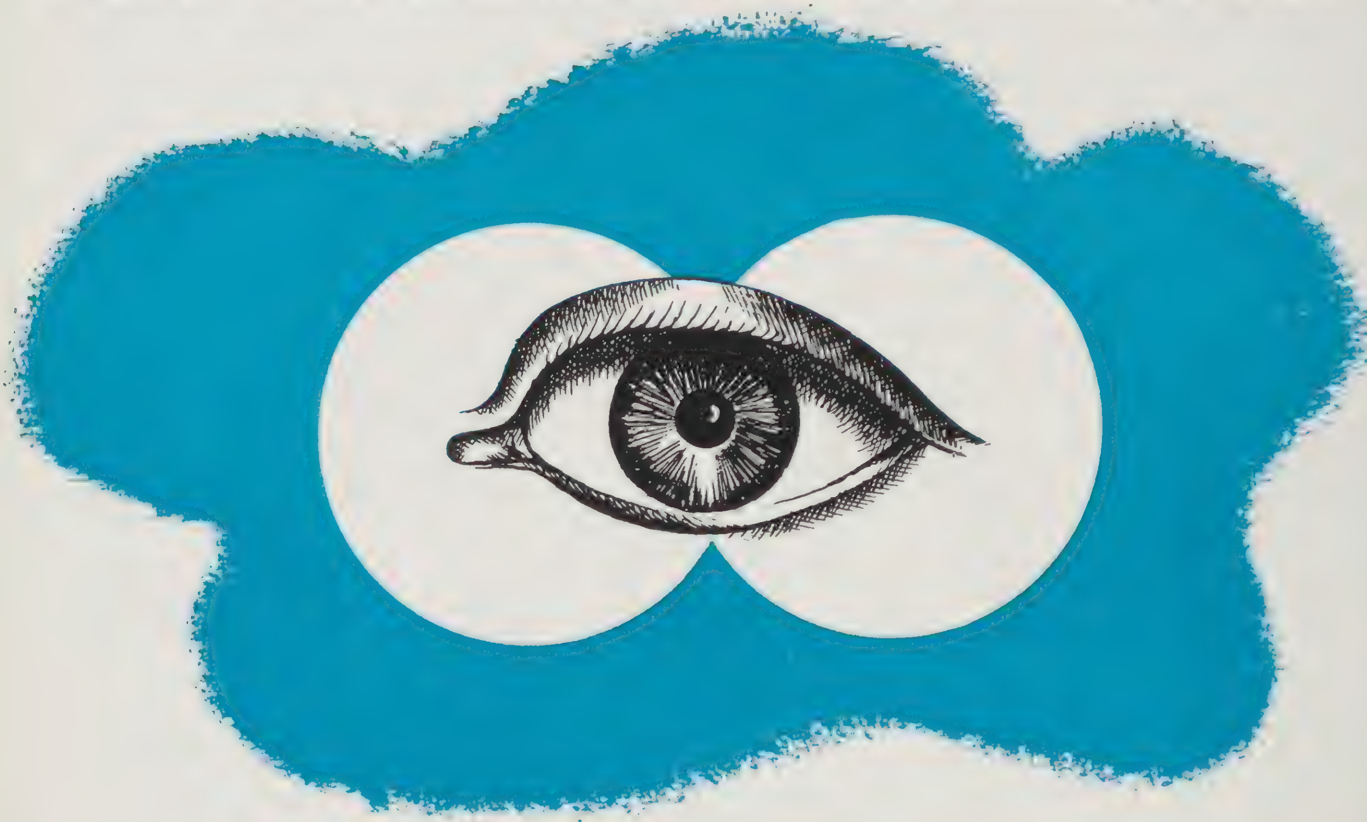
RETINAL PROJECTION



Common errors

1. Failure to ascertain the sighting and non-sighting eyes.
2. Failure to place the Maddox rod and Risley prism before the non-sighting eye.
3. Failure to shield extraneous light from the examinee, thereby producing confusing streaks.
4. Conducting the test with the rotary prism and Maddox rod in improper position.
5. Failure to allow the examinee to turn the milled head of the prism.
6. Failure to practice intermittent occlusion of the non-sighting eye.
7. Incorrect interpretations of the rotary prism findings.

POWER OF DIVERGENCE EMPLOYING THE ROTARY PRISM



Equipment. Standard double or single phorometer; 1-cm spotlight or muscle lamp; if phorometer is not available, spectacle trial frame and prisms from the trial case.

Procedure. If the examinee habitually wears correcting lenses while flying, or such correction is necessary to meet distant and near visual acuity standards, he must wear his correction during the test. His correcting lenses necessarily must contain no prismatic correction. The examinee is seated facing the muscle lamp 20 feet away as in the determination of muscle balance. A rotary prism of the phorometer is adjusted before one eye with the zero mark of the scale in the vertical position and the strength marker set exactly at zero. The examinee is directed to fix upon the spot of light, and the examiner slowly rotates the prism base in. As the prism is rotated in this manner, the muscle lamp, as seen by the examinee, eventually blurs and then separates into two distinct spots of light. The number of prism diopters which causes the light definitely to blur, or the maximum strength prism, base in, which he is able to overcome by divergence, is the measure of his power of divergence in prism diopters and is so recorded.

Precautions. The examinee should be told to exert an effort to maintain fusion as the prism increases in strength. Examiners are cautioned that the strength of the prism which first causes an actual diplopia (with separation of the images), is not the measure of the diverging power, because the examinee is manifestly unable to overcome it. The maximum power of divergence is always determined, for if excessive, it may disqualify. Occasionally the examinee will state that he sees two lights as soon as the marker is turned away from zero. The second light which he sees is frequently a dim reflection from the surfaces of the prism itself, and does not represent a true diplopia; the examinee is instructed to ignore the dim light and to report only the beginning of blur of the bright light.

Common errors

1. Failure of the examiner to describe the test to the examinee.
2. Attempts to use the Maddox rod or two rotary prisms.
3. Failure of the examiner to turn the milled head of the prism.
4. Failure to turn the prism *base in.*

THE RED LENS TEST

Equipment. The red lens from the trial lens case, or a large red lens mounted in goggle frame or on suitable hand grasp; small lamp such as an unshielded ophthalmoscope lamp; and wall space suitably marked for the estimation of distances. A string is secured to a nail or screw placed in the wall four feet above the floor. A knot is tied in the string at a distance of 75 cm (30 inches) from the wall. Faint meridional lines are drawn from the screw in the vertical, horizontal, and four diagonal directions; these lines are faintly marked at 10 cm intervals.

Procedure. If the examinee wears correcting lenses while flying to meet distant and near visual acuity standards, he is required to wear his correcting lenses during the test. The correcting lenses may not contain prismatic corrections. The examinee is seated, head erect, before the prepared wall surface, with his eyes 75 cm directly in front of the central point marked by the screw (this central point marks the primary position). The examinee holds the red lens before either eye but not pressing against the lids. The examiner holds the light against the wall at the primary position. As the examiner occludes the examinee's eyes alternately, he explains that with the one eye the examinee sees the light as red, with the other as white, and with both eyes open as "mixed" (pink). The examiner instructs the examinee to report immediately when he sees two separate lights, one red and the other white (diplopia), or when the color of the light changes from "mixed" to either red or white (suppression), as he follows the movement of the light with his eyes. Presence or absence of diplopia or suppression is noted in the primary position. The examiner moves the light along each of the meridional lines to a distance of 50 cm (20 inches). The absence of diplopia or suppression is noted in each of these eight meridians. A diplopia is uncrossed when the red image appears on the same side as the eye before which the red lens is placed, crossed when it appears on the opposite side of the white image. If neither diplopia nor suppression is found, the notation "Normal" is made. When *diplopia* is found within 50 cm of the primary position, it is described in the following characteristics:

Type of diplopia, crossed or uncrossed;

The distance from the primary position at which diplopia first occurs;

The meridian or meridians involved.

(Example: "Crossed diplopia at 30 cm in upper right meridian.")

When *suppression* is detected, it is described in the following characteristics:

Whether of the right or left eye;

The distance from the primary position at which suppression first occurs;

The meridian or meridians involved.

(Example: "Suppression of the left eye at 35 cm in upper vertical meridian and at 40 cm in upper right meridian.")

Limitation of the fields of rotation of the eyes in certain meridians by the anatomic conformation of the brow or nose is not regarded as a suppression.

Precautions

1. Where diplopia may be suspected and the examinee coached to deny its presence, a prism of 5 diopters, base up or down, may be placed before one eye. If binocular vision is present and diplopia is still denied, the statement is obviously untrue. The prism may be alternately replaced by a weak spherical lens (minus .12) in order to confuse the examinee.
2. Care is exercised to avoid the confusion of a true suppression with an erroneous interpretation of color by the examinee. A reported change of color of the light may not actually be due to suppression. An examinee has a true suppression when the color of the light is unaffected by occlusion of the opposite eye. For example, the examinee may report a change of color from "mixed" to red while the light is still obviously within the field of rotation of both eyes. Occlusion of the eye not covered by the red lens produces no subject change in the color of the light; the eye not covered by the red lens is truly suppressing.
3. Development of a crossed diplopia in the upper meridian is frequently associated with inadequate power of convergence; this association should be borne in mind by the examiner while conducting both tests.

Common errors

1. Failure to give adequate instruction to the examinee.
2. Failure to place the examinee's eyes 75 cm (30 inches) before the primary position marked on the wall.
3. Failure to instruct the examinee to follow the light with his eyes.
4. Permitting the examinee to move his head.

5. Failure to carry the light out from the primary position along the plane of the wall.

6. Failure to carry the light to 50 cm (20 inches) in each of the 8 meridians.

7. Failure to determine whether the examinee's lack of response means that he has no diplopia.

8. Failure to differentiate a true suppression from an erroneous interpretation of color by the examinee.

9. Lack of patience in conducting the test.

10. Incorrect recording of significant findings.

OPHTHALMOSCOPIC EXAMINATION

Equipment and drugs. The electric ophthalmoscope; a mydriatic solution, such as homatropine hydrobromide 1%, euphthalmine 2%, ephedrine sulphate 2%, or paredrine 1%, a miotic solution, such as pilocarpine nitrate 1%, or eserine salicylate ½%.

Procedure. On the original examination a mydriatic is employed before the ophthalmoscopic examination but on succeeding examinations it is used when the examiner suspects the presence of intraocular pathology, or when he is unable to conduct a satisfactory examination through the undilated pupil. To prevent the possible development of a post-mydriatic glaucoma, particularly in examinees over 35 years of age, the examination should be followed by the instillation of a miotic solution in each eye; the instillation is repeated once after a 5 minute interval.

The examiner should wear his correction if he possesses sufficient astigmatism to render his view indistinct without correction. The examinee's right eye is viewed with the examiner's right eye; examinee's left with examiner's left. The following technique of direct ophthalmoscopy is recommended.

1. Interpose a plus 8 diopter lens in the aperture of the ophthalmoscope, and hold the instrument at about 12 cm from the examinee's eye. Opacities on the cornea or within the ocular media are readily observed against the red background of the fundus reflex, although their exact positions within the globe are not revealed. By moving his head slightly from side to side, the examiner may estimate the approximate depth of an observed opacity.

2. Interpose a plus 20 diopter lens in the aperture and hold the instrument approximately 5 cm from the examinee's eye. Study of the illuminated cornea, iris, and anterior lens surface is facilitated by the magnification thus obtained.

3. Without changing the position of the ophthalmoscope in relation to the examinee's eye, interpose successively weaker plus lenses in the aperture until retinal details are discerned. Progressively deeper planes within the globe are thus brought into focus, and opacities within the media of the eye are more readily observed.

4. A weak minus lens may be required to bring retinal details into clear definition. The fundus is examined thoroughly and any abnormality of the disc, macula, blood vessels, retina, and choroid noted. Peripheral portions of the fundus are examined by having the examinee direct his gaze up, down, to the right, and to the left.

Precautions. The instillation of a mydriatic is contraindicated when evidence of increased intraocular tension exists. Pathological conditions of the retina and choroid frequently are indicative of systemic diseases. Particular attention should be paid to the ophthalmoscopic examination of individuals past mid-life and of others in whom arterial sclerosis may be suspected. The ophthalmoscopic examination is indicated following cranial injury. Any abnormality found is to be classified and described accurately and, where possible, substantiated by other findings (visual field defects, reduction in visual acuity, etc.), Lenticular opacities should be described as to appearance, location, and interference with function.

For the technique of refraction, and of neutralization of lenses, see TM 8-300 and standard texts.

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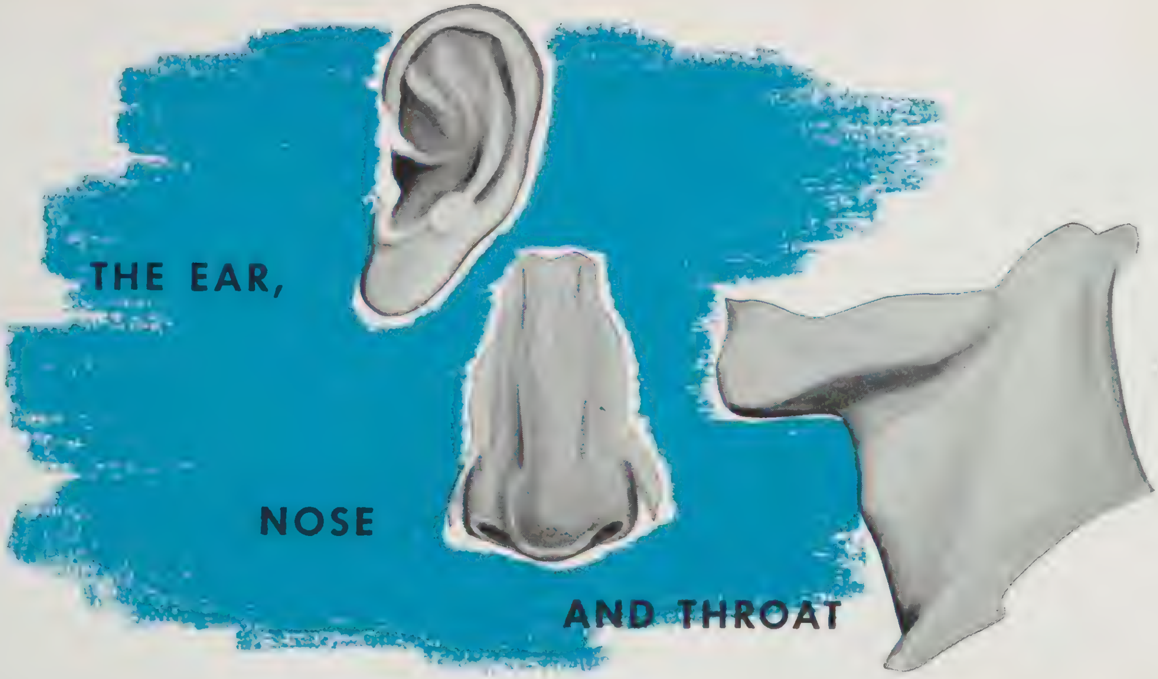
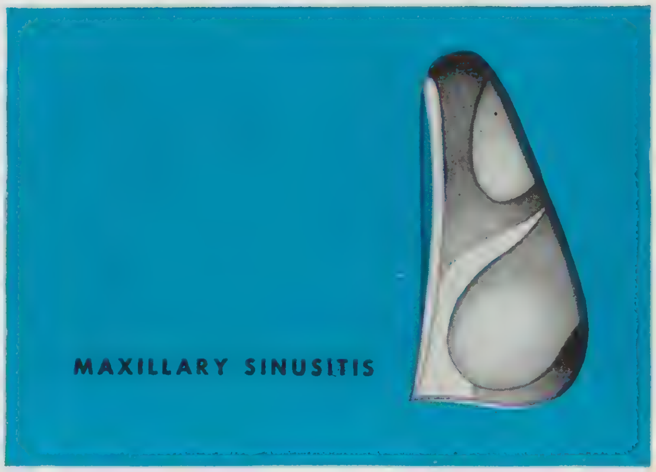


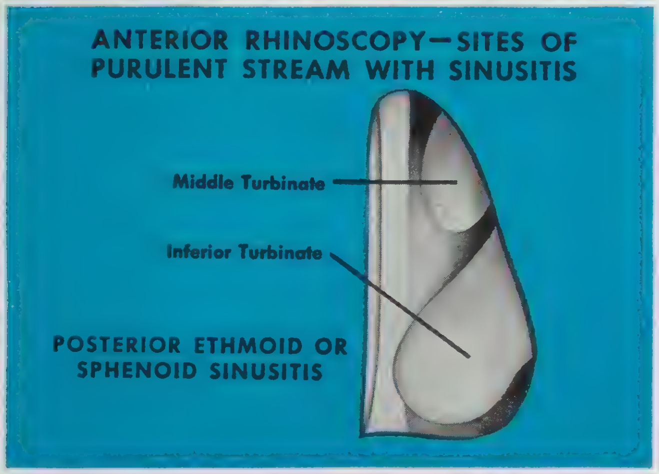
Technique

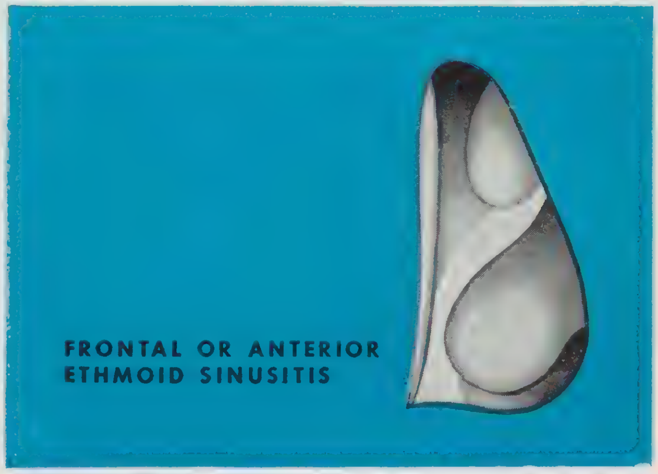
The examination of the ear, nose and throat will involve (1) anamnesis, (2) local examination, (3) transillumination of sinuses when indicated and (4) x-ray.

The nose

The nasal speculum and the head mirror are used ordinarily for the examination of the anterior nares. Particular attention is devoted to the estimation of the amount of free airway on each side, the extent of obstruction caused by deviations or spurs of the nasal septum, the presence and source of purulent discharge and any other abnormality which may restrict the normal function of the nose.





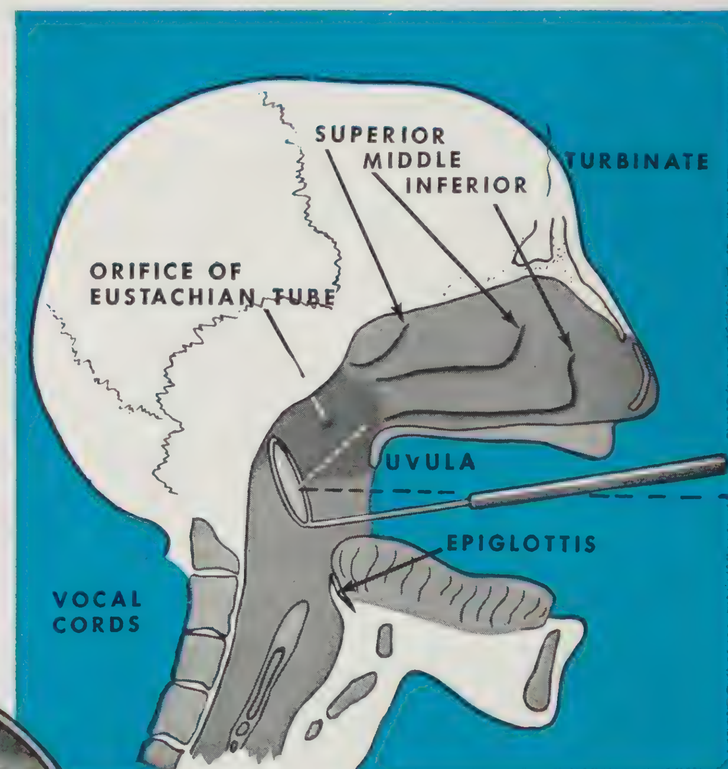


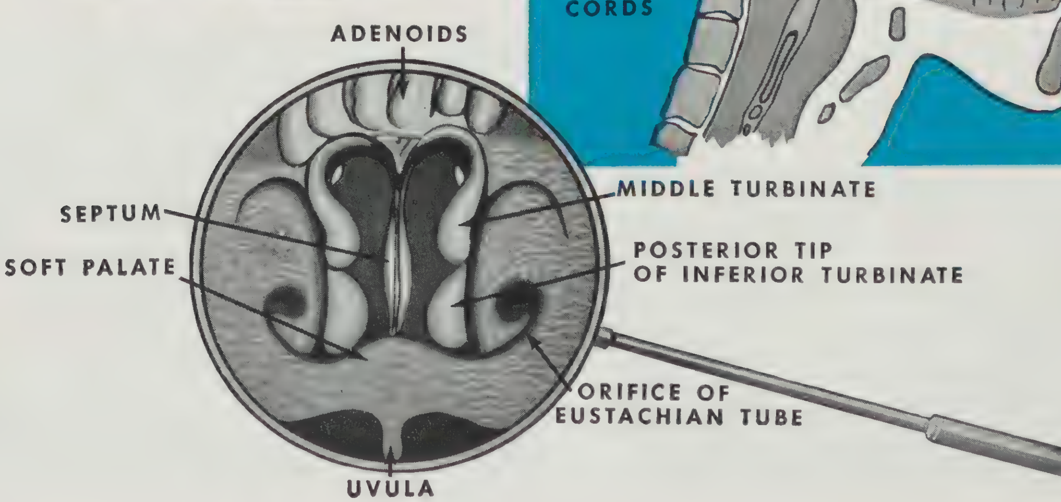
Mouth and oropharynx

These are examined with the aid of a head mirror or flashlight and tongue blade. The condition of the tonsils, if present, is carefully evaluated; the presence of lymphoid nodules and lateral bands in the oropharynx is an indication for a search of the rhinosinusal area for the existence of a primary infection. The floor of the mouth is inspected for evidence of ranula, calculi, ulcers, adhesions, or other lesions.

The nasopharynx

The nasopharynx is examined usually by reflected light and the nasopharyngeal mirror. The examinee is instructed to "pant" through his mouth as the shaft of the mirror is seated in the angle of the mouth and the mirror carried diagonally across the tongue toward the opposite tonsillar fossa. Just medial to the anterior tonsillar pillar the mirror is carried posteriorly between the uvula and the posterior tonsillar pillar to a position in the oropharynx. The examinee then breathes through his nose which allows the soft palate to drop downward and forward. The mirror may be rotated so that the various nasopharyngeal structures are seen. The appearance of the posterior tips of the middle and inferior turbinates, the presence of adenoid tissue or cicatrices about the ostia of the Eustachian tubes, and evidence of infection are of primary interest. When practicable an examination with the electric nasopharyngoscope should be done. The evidence obtained, particularly by one familiar with the instrument, may be more conclusive than that obtained by the mirror.





The Eustachian tubes

Normally functioning Eustachian tubes are important to flying personnel. A retracted tympanic membrane, a history of aero-otitis media, or abnormalities about the ostia of the Eustachian tubes make it necessary to determine their patency.

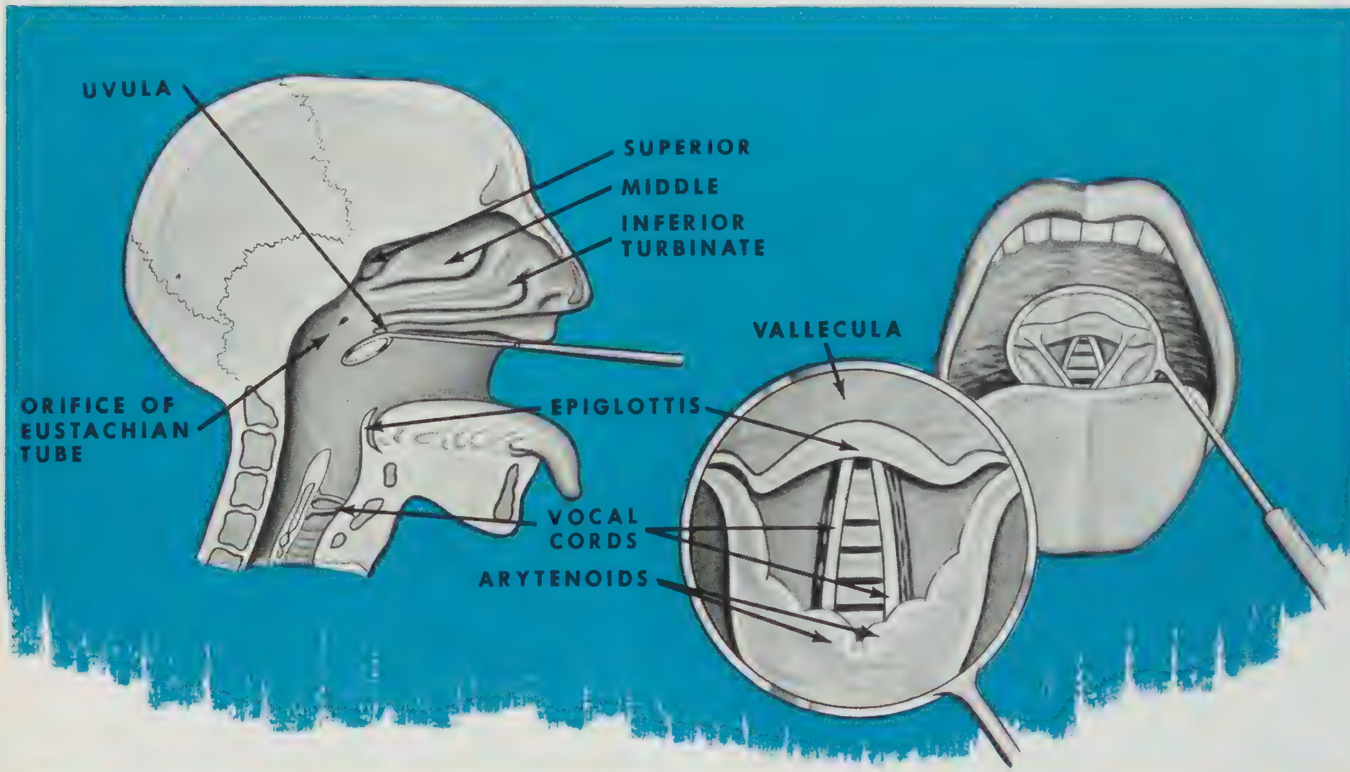
The simplest procedure is the Valsalva maneuver. With the tympanic membrane in view of the examiner, the examinee holds his nostrils closed with the finger of one hand, shuts his lips tightly, and expires forcefully. Positive pressure is produced in the nasopharynx, and causes air to enter the middle ear cavity if the Eustachian tube is patent. The examiner is able to note an increased convexity of the tympanic membrane, especially in Shrapnell's area, and in the posterior superior quadrant of the drum.

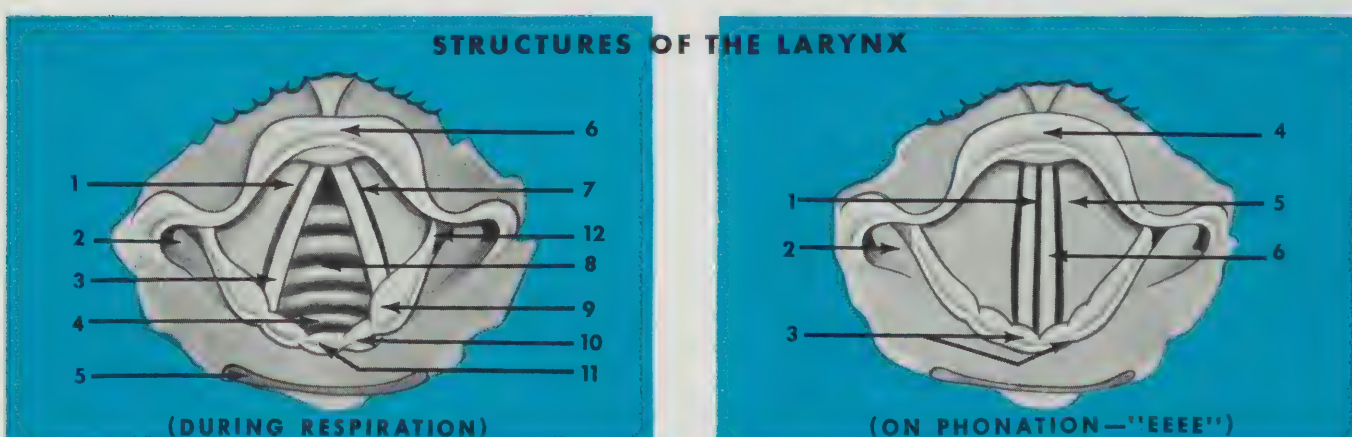
Another method is the basic Politzer technique. It consists of placing one ear piece of the auscultation tube in the external auditory canal of the examinee and the other in the external auditory canal of the examiner. The tip of a Politzer bag is fitted with a nasal adapter which is seated in one anterior naris. The other side of the nose is closed firmly with a finger and as the examinee swallows or says "K," the Politzer bag is compressed. If the Eustachian tube is open, air will be heard to rush up the tube. An easier method, which does away with the need of synchronizing the compression of the Politzer bag with the examinee's closure of the nasopharynx, is that of "constant pressure inflation." Air under pressure of 1 psi is fed into one side of the nose through a nasal tip. The other side of the nose is occluded and the examinee swallows at will. The results are apparent from the sounds coming to the examiner through the auscultation tube or from observation of the ear drum.

Catheterization of an apparently occluded Eustachian tube should be performed only by those specially trained in the technique.

The hypopharynx and larynx

The hypopharynx and the larynx are visualized, usually, with reflected light from the head mirror and the large laryngeal mirror. Gauze is wrapped around the tip of the examinee's tongue and he is instructed to breathe through his mouth. The tongue is firmly but gently pulled forward and downward, out of the mouth. The shaft of the mirror is seated in the angle of the mouth and the head of the mirror is carried directly back over the tongue into the oropharynx elevating the uvula. The inspection is concerned mainly with the appearance and function of the true cords and the adjacent structures.



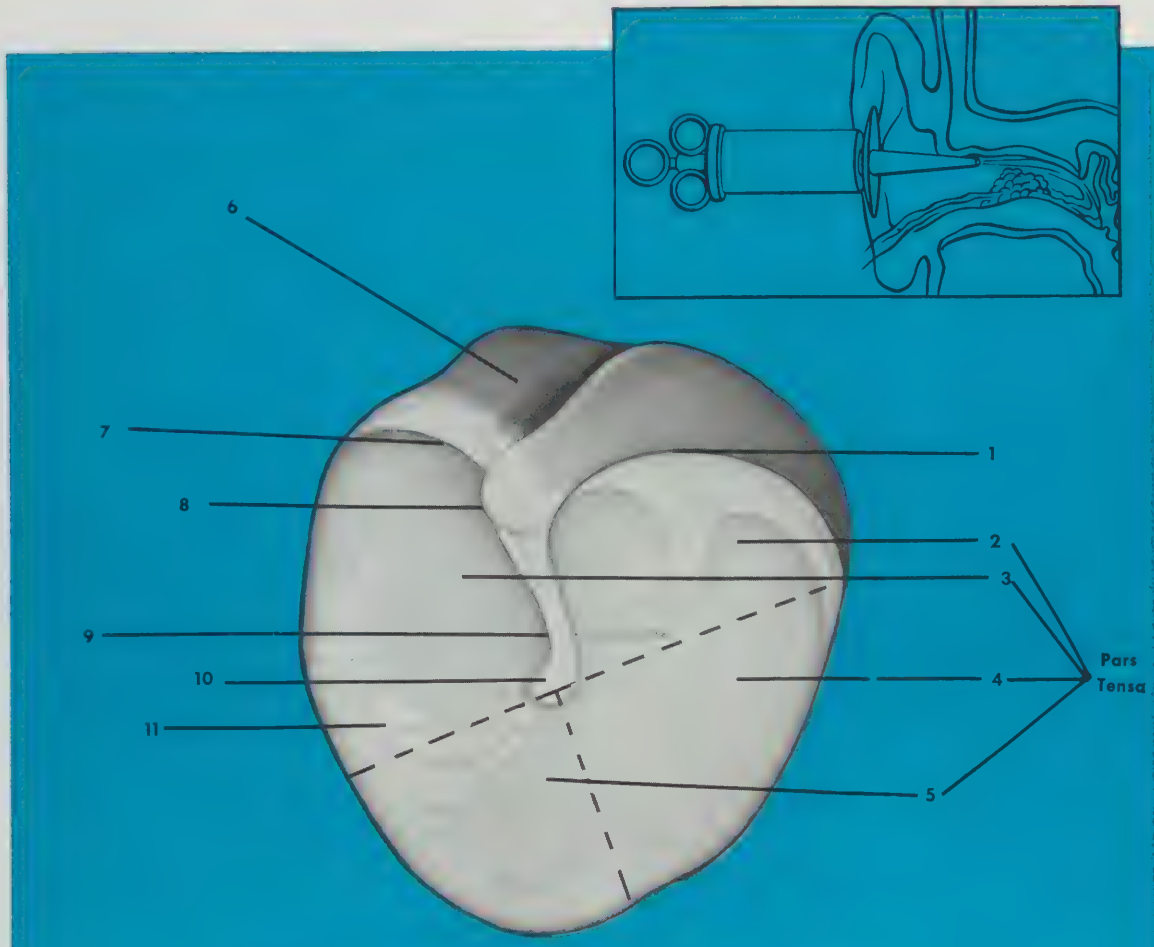


1. Ventricular Band (False Cord). 2. Pyriform Sinus. 3. Vocal Cord. 4. Glottis. 5. Esophagus. 6. Epiglottis. 7. Aryepiglottic Fold. 8. Trachea. 9. Cuneiform Cartilage. 10. Corniculate Cartilage. 11. Interarytenoid Sulcus. 12. Ventricle.

1. Glottis. 2. Pyriform Sinus. 3. Arytenoid Cartilages. 4. Epiglottis. 5. Ventricular Band (False Cord). 6. True (Vocal) Cord.

External ear and tympanic membrane

The auricle, external auditory canal, and tympanic membrane are examined with reflected light from a head mirror directed through an aural speculum, or with the electric otoscope. Accumulated cerumen obstructing the view of the tympanic membrane must be removed. Unless a perforation of the drum is known to be present, or is suspected, the cerumen may be flushed out by irrigation with warm (100°F) saline, sodiumbicarbonate solution, or water.



THE LANDMARKS OF THE NORMAL TYMPANIC MEMBRANE
(LEFT)

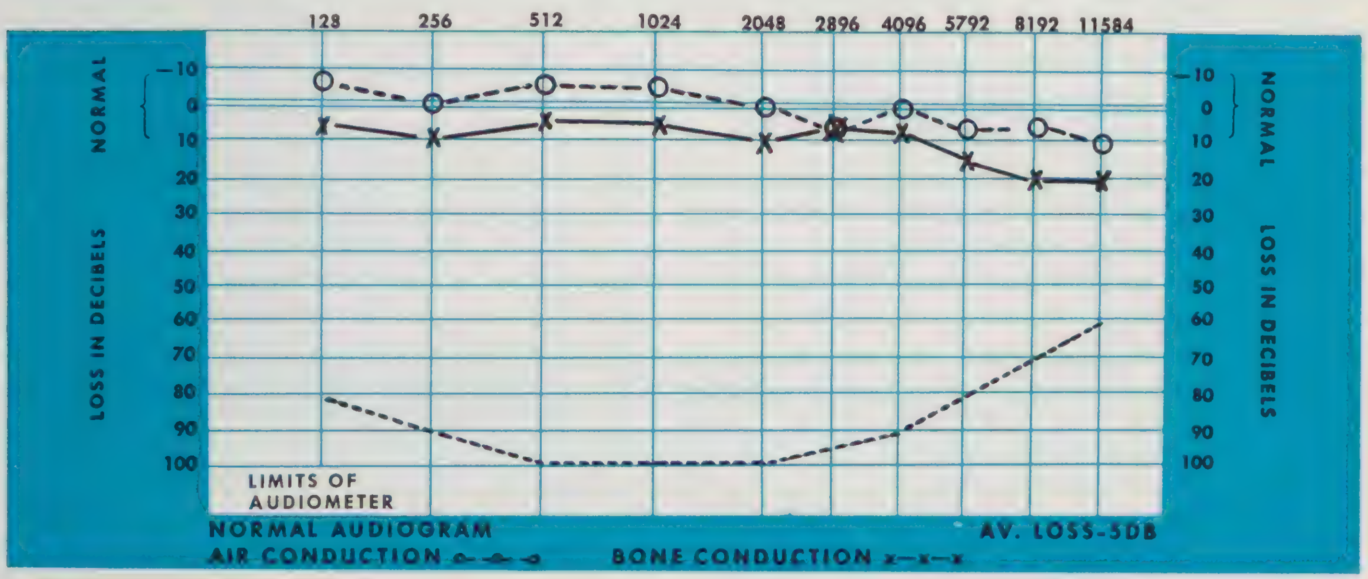
1. Posterior Malleal Fold. 2. Posterior Superior Quadrant. 3. Anterior Superior Quadrant. 4. Posterior Inferior Quadrant. 5. Anterior Inferior Quadrant. 6. Pars Flaccida (Shrapnell's Membrane). 7. Anterior Malleal Fold. 8. Short Process of Malleus. 9. Long Handle of Malleus. 10. Umbo. 11. Light Reflex.

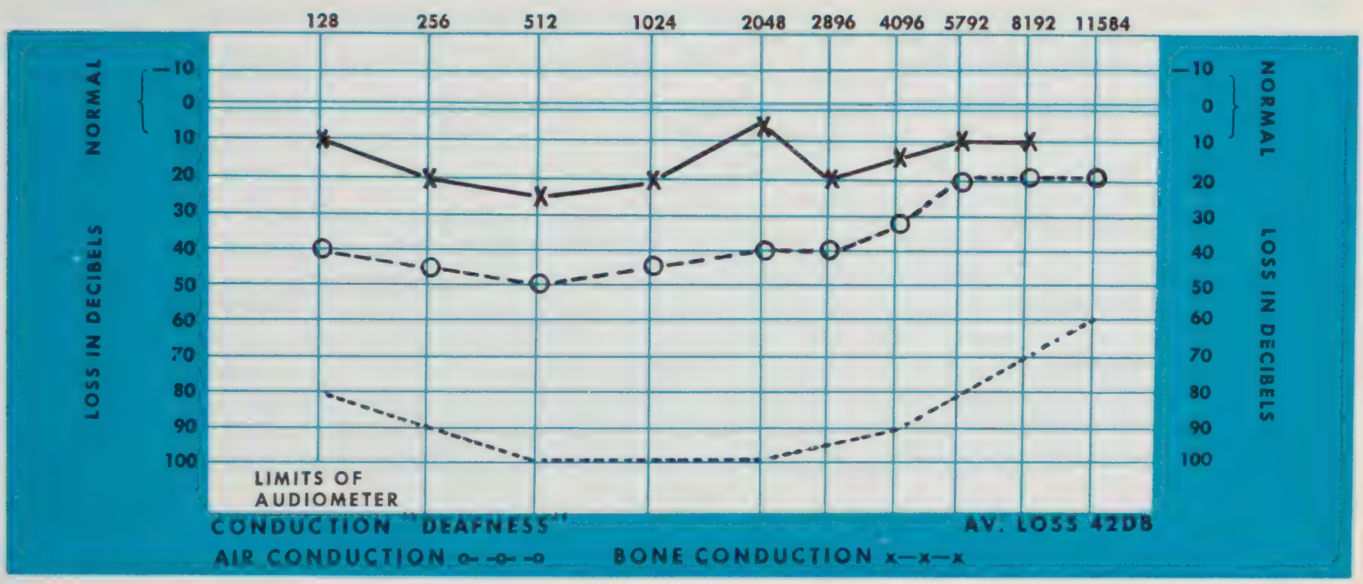
HEARING

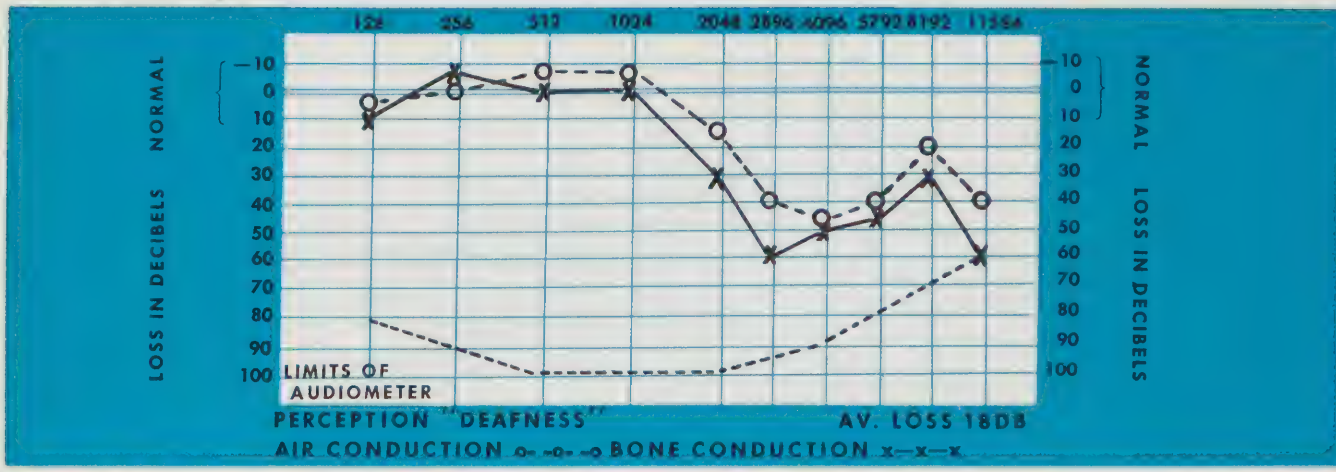
Voice Tests. The Whispered Voice Test, if carefully performed, will separate the examinees with normal hearing from those with abnormal hearing. It is performed with the examinee at a distance of 15 feet from the examiner. The examinee stands sideways so that he cannot see the examiner's lips and occludes the ear farthest from the examiner. If there is any doubt as to the reliability of the examinee the ear not being tested is occluded by the examiner's assistant. Using the breath which remains after a normal expiration the examiner whispers or speaks selected numerals or words. In general, the numbers 2 and 4, and vowel words represent low frequencies; 8 and 9 and consonant words are middle frequency sounds; while 6 and 7 and sibilant words predominate with high frequencies. Subnormal hearing is indicated by recording the distance to which the examiner needs to advance, as measured from the examinee, in order that the examinee is able to repeat correctly the numerals or words presented to him.

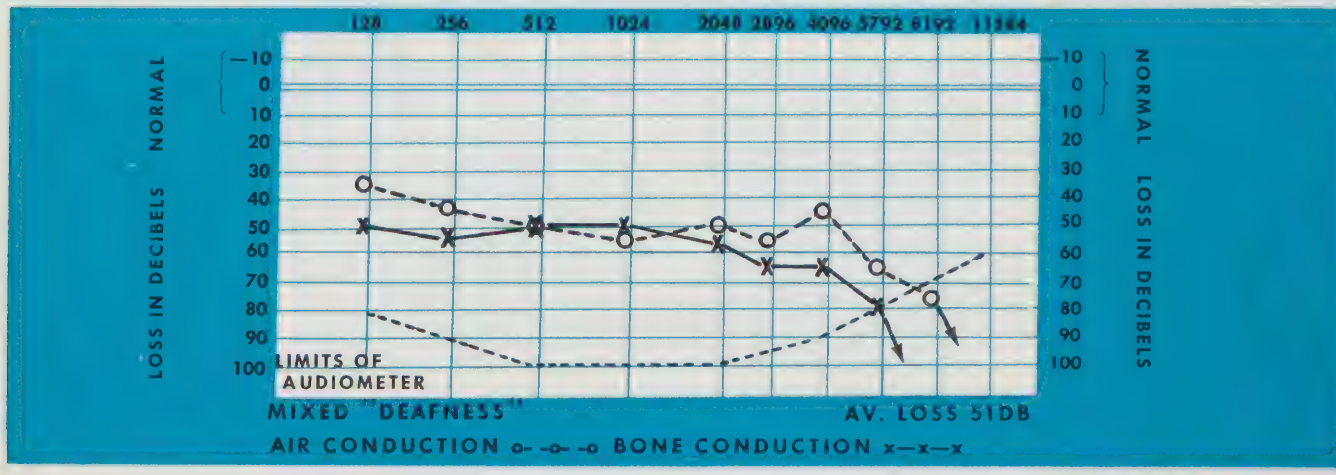
The audiometer

The audiometric examination is the most accurate method of determining auditory acuity. An advantage is that it provides a permanent record for reference (see Section 8-6). The selector dial of the functioning audiometer is set, usually, at the lowest tone —64 for air conduction and 128 for bone conduction—and the intensity dial is turned to 20 or 30 decibels so that the examinee may appreciate the tone he is to listen to. The appropriate receiver is held by the examinee to the ear being tested. He is instructed to indicate when the tone is no longer heard. Ordinarily the auditory acuity by air conduction for both ears is determined and charted first, then the auditory acuity by bone conduction. The easily heard tone is gradually decreased in intensity until the examinee signals that the tone is heard no longer. The decibel intensity at this point is noted from the dial and is checked by increasing the loudness until the examinee again just hears the tone. The threshold of hearing for the individual is the level at which the examinee just barely *hears* the tone and not the point where the tone fades out. Each tone indicated on the selector dial is tested and recorded in a similar manner. The "average" hearing loss with air conduction is determined by adding the loss in decibels at frequencies 512, 1024, and 2048 cps, and dividing by 3.









INTERPRETATION OF HEARING TESTS

TEST	NORMAL	CONDUCTION DEAFNESS	PERCEPTION DEAFNESS	MIXED DEAFNESS
Whispered Voice (Stage Whisper)	15/15	Usually less than 15/15	Usually less than 15/15	Usually less than 15/15
Rinne'	AC greater than BC	BC greater than AC	AC greater than BC, but both diminished	AC=BC
Weber	No lateralization	Lateralized to lesion	Away from lesion	Varies
Schwabach	BC same as examiner's	BC better than examiner's	BC poorer or same	BC poorer or same
Audiometer	Normal	Usually loss of low tones	Usually loss of high tones	May be general loss

LABYRINTH (INNER EAR)

The labyrinthine tests were designed to afford information with regard to the functioning of the equilibratory part of the inner ear, the vestibular organ.

The Romberg Test is the simplest test and consists of having the examinee stand with both feet together, to minimize the proprioceptive factor, and with eyes closed, to eliminate the ocular factor. If unusual swaying or falling is noted, the vestibular organ should be investigated by the rotation or caloric tests.

The Rotation Test. The patient is seated in a Barany Chair with the head flexed 30° forward so that the tragus of the ear is on a horizontal plane with the external canthus of the eye. The chair is turned to the right 10 times in 20 seconds (the maximum speed being attained during the first turn), then stopped suddenly. The resulting reactions are nystagmus (quick component) to the left (10 to 34 seconds, average 26 seconds), vertigo to the left, past pointing and falling to the right. Subsequently, the examinee is turned to the left in a similar manner resulting in nystagmus (quick component) and vertigo to the right, past pointing and falling to the left. There should not be a variation of more than 5 seconds between the durations of nystagmus following the turning in each direction.

After performing a caloric test by lavaging the right ear with water (68° F). Nystagmus and vertigo to the left; falling and past pointing to the right.

Caloric Test. Since the two common caloric tests depend on the instillation or irrigation of the ear with water, the external auditory canal must be clean and the examiner must have assured himself that there is no existing perforation of the tympanic membrane. In the presence of perforation, the rotation test may be used. The "lavage test" consists in douching the right ear with water at 68°F until nystagmus is noted. The average normal latent period is 30 to 40 seconds and the average normal duration of the nystagmus is about 120 seconds. The results are nystagmus and vertigo to the left, past pointing and falling to the right. The left aural labyrinth is tested in the same manner and the timed periods of the two ears should be within 5 seconds of each other. The "instillation test" consists of instructing the examinee to place his head on a table so that the ear to be tested is directly above the opposite ear. One cc of ice water (40°F) is instilled into the upper ear. As soon as nystagmus is noted the head is raised to the upright position. The average normal latent period is 30 seconds and the average normal duration of the nystagmus is 120 seconds. If the right labyrinth is stimulated, the nystagmus and vertigo are to the left while the past pointing and falling are to the right. The left labyrinth is tested in the same manner and produces nystagmus and vertigo to the right, past pointing and falling to the left. The timed periods of nystagmus after stimulation of each ear should be within 5 seconds of each other.

SINUSES AND MASTOIDS

In addition to the information obtained from the history and the physical examination of the ears, nose and throat, further information about the sinuses and mastoids may be obtained by superficial inspection, palpation, transillumination and X-ray studies. Transillumination is applicable only to the maxillary and frontal sinuses. X-rays provide information concerning all the paranasal sinuses, the aural structures and the adjacent tissues.

Inspection

Tumefaction of the face during a sinusitis or of the aural area during otitis is usually indicative of an extension of the process into the external tissues. If the edema results from a maxillary, frontal or ethmoidal infection it is assumed, in order of progression, that there is an external periostitis, cellulitis or abscess with an intervening osteitis or even osteomyelitis. Edema about the ear accompanying an external otitis usually indicates a perichondritis and periostitis with cellulitis. If the infection involves the mastoid the edema leads one to suspect osteitis or osteomyelitis with periostitis and cellulitis. Clinical edema is not characteristic of the usual type of ear, nose and throat lesion.

Palpation

Tenderness may not be elicited unless there is a periostitis or perichondritis. The preferred pressure point for testing the frontal sinus is the floor (under the supra-orbital ridge medially—Ewing's point). The pain elicited by pressure on the supra-orbital nerve in this area should not be accepted as true tenderness caused by frontal sinusitis. Tenderness from the maxillary sinusitis is determined best by palpation in the canine fossa. An acute, severe otitis media often causes a superficial tenderness of the mastoid to light palpation during the first 4 to 5 days. Tenderness from true mastoiditis develops after the first week and is elicited only by strong pressure ("deep" tenderness). These two types of pressure pain should not be confused since the early superficial tenderness is not an indication for surgery of the mastoid.

Transillumination

Transillumination of the frontal sinuses is accomplished in a dark room by pressing twin lights against the floor of the frontal sinuses and comparing the glow which is transmitted to the anterior wall of each sinus. The maxillary sinuses may be transilluminated either by placing the twin lights in the infra-orbital area and comparing the intensity of the light appearing on each side of the hard palate, or by inserting the light in the mouth and noting the illumination which appears in each infra-orbital region and at the pupils of the eyes. Normal sinuses transmit a rosy glow of similar intensity on each side. Unilateral mucosal or osseous thickening, fluid, or developmental defects will reduce the transillumination on the affected side proportional to the involvement.

X-ray

X-rays of the normal sinuses and aural structures show the sharp, bony septa of the mastoid and ethmoid cells and the clear-cut walls of the frontal, maxillary and sphenoid sinuses. Cavities in the sinuses and mastoids are of comparable density with that of the orbit. Pathological conditions are indicated by the cavity shadows becoming "cloudy," (i.e., approaching the density of the osseous shadows), and blurring of the sharp osseous walls by loss of definition and thickening of the mucosa. Occasionally, a fluid line may be seen, and the details of underlying structures are obscured.

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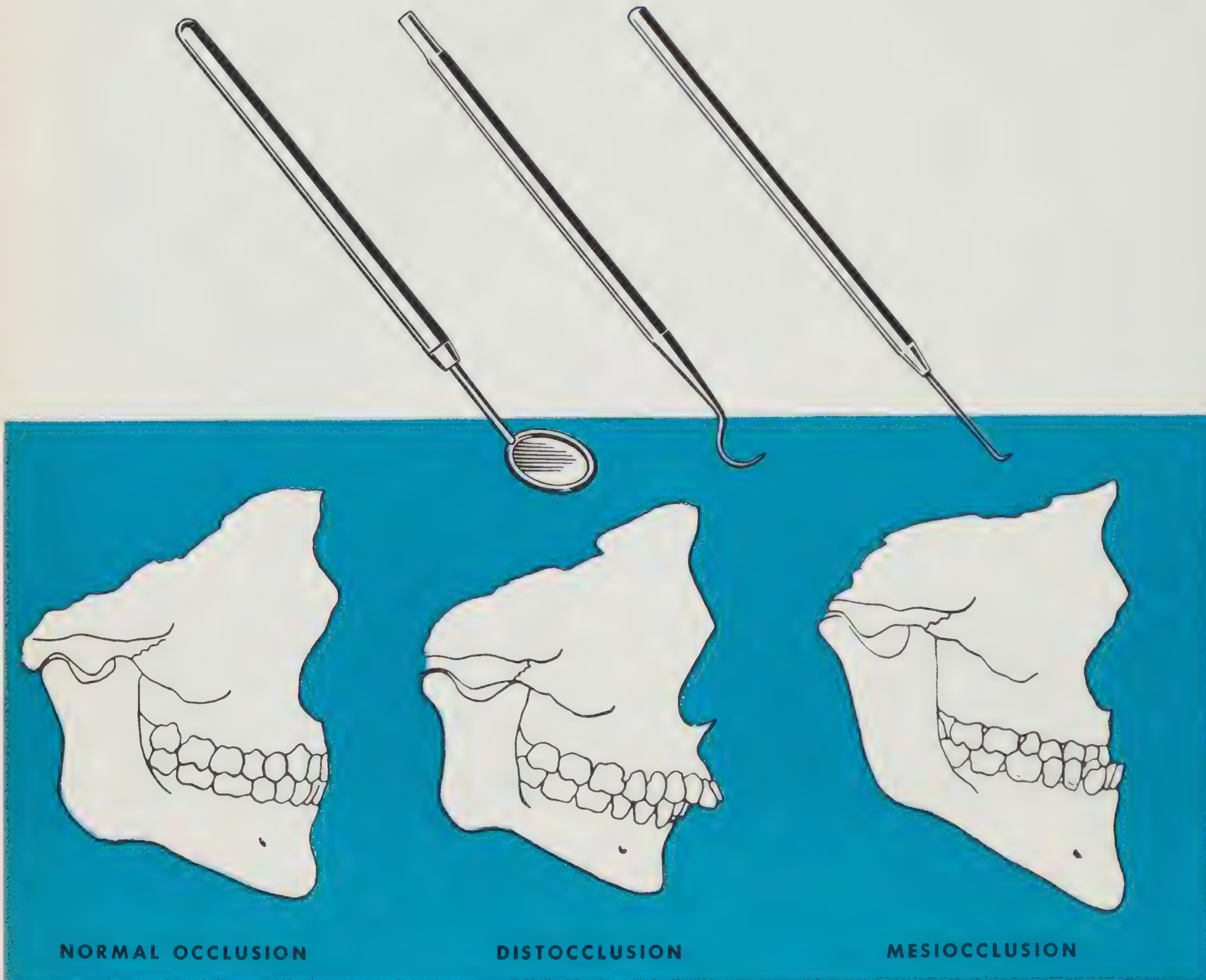
THE DENTAL EXAMINATION



Technique.

The patient is examined under a good light with the aid of a mouth mirror. The lips and cheeks are retracted and the soft tissues examined.

Vincent's gingivitis or stomatitis may be detected by the presence of spongy, hyperemic tissues around the necks of the teeth. In disease, the appearance of the gums may range from an unhealthy bright red to purple, with sloughing and a greenish-grey pseudomembrane, especially between the teeth.

Subjective symptoms of oral discomfort, frequent gingival hemorrhage, and, in severe cases, pyrexia and malaise will verify the diagnosis. Vincent's infection usually appears in unclean mouths which contain much tartar or calculus around the necks of the teeth. The lower anterior and upper molar teeth are most frequently affected. It frequently appears in an acute, localized form in the region of an incompletely erupted lower third molar, often referred to as a parietal or pericoronal abscess.

Missing teeth, loose teeth (periodontoclasia), and *prosthetic appliances,* if any, are noted.

Using a curved or right angle explorer each tooth is examined for *caries.* Any pit which will support the weight of the explorer after insertion of the explorer point may be classed as carious.

Check all surfaces of each tooth for darkened areas (not stain). A bluish-black appearance of translucent enamel, especially near the proximal surfaces of a tooth, often indicates underlying decay or the presence of a dark metallic filling.

A broad classification of *malocclusion* is valuable for record. *Mesiocclusion* (prognathism) is evidenced by the lower teeth resting forward, or anterior to the upper teeth. In *distocclusion,* the lower teeth come to rest generally distal (posterior) of normal, causing the upper anterior teeth to appear protruded.

In case of a marked malocclusion which is considered disqualifying, dental casts will be forwarded to the Air Surgeon. In the absence of a dental officer, a civilian dentist may make these casts in the case of civilian applicants for flying training. No expense to the government will be incurred in this connection.

Dental classification of individuals

Depending on the oral findings individuals are classed as follows:

Class I—Persons requiring immediate treatment of conditions such as:

(a) traumatic injuries
(b) acute infections (pulpitis, gingivitis, stomatitis, etc.)
(c) conditions necessitating extractions
(d) defects not listed above but of a nature requiring emergency treatment
(e) insufficient teeth to masticate the army ration.

Class II—Persons requiring early treatment (favorable cases for preventive dentistry, except persons in Class I) such as:

(a) filling operations which do not involve pulp canals
(b) replacement of defective fillings (except root canal fillings)
(c) prophylactic treatment
(d) correction of defects not listed above but of a nature favoring preventive procedures, including orthodontia.

Class III—Persons requiring extended treatment (constructive dentistry, except persons in Class I and Class II), such as:

(a) treatment of chronic infections
(b) filling operations involving pulp canals
(c) replacement of defective root canal fillings
(d) construction of crowns, bridges, and dentures
(e) correction of defects not listed above but of a nature requiring extensive treatment

Loss of one or two teeth does not necessarily warrant Classification III.

Class IV—Persons not requiring dental treatment.

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TESTING OF APTITUDE

Paper and Pencil Tests. Group tests of this type comprise a large portion of the comprehensive battery of psychological aptitude tests taken by aviation cadet candidates.

The primary mission of psychologists assigned to the Medical Department of the AAF is to devise methods of selecting aircrew trainees and classifying them as pilots, bombardiers, and navigators. The term "selection" implies the detection and disqualification of applicants whose chances for success are low, so as to fill quotas with men whose success in training is sufficiently probable to justify an investment in them. Similarly, classification means the weighing of each man's relative aptitudes and his assignment to the type of training for which he is best suited.

In order to determine an applicant's chances for success, it is necessary to develop measures which will differentiate potential graduates from potential eliminees. For example, suppose a test is developed and given to a large number of applicants who are then admitted to training without regard to test score. It may be found that of those who scored in the upper third of the group on the test only 15% are eliminated in training, while of those who scored in the lower third, 45% are eliminated. If it is assumed that elimination policy remains relatively constant, it may be predicted that an individual who scores in the upper third has 85 out of 100 chances to graduate, while an individual in the lowest third has only 55 out of 100 chances. This process of "testing the test" is called *validation.* A test which successfully differentiates groups with high and low graduation rates is called valid.

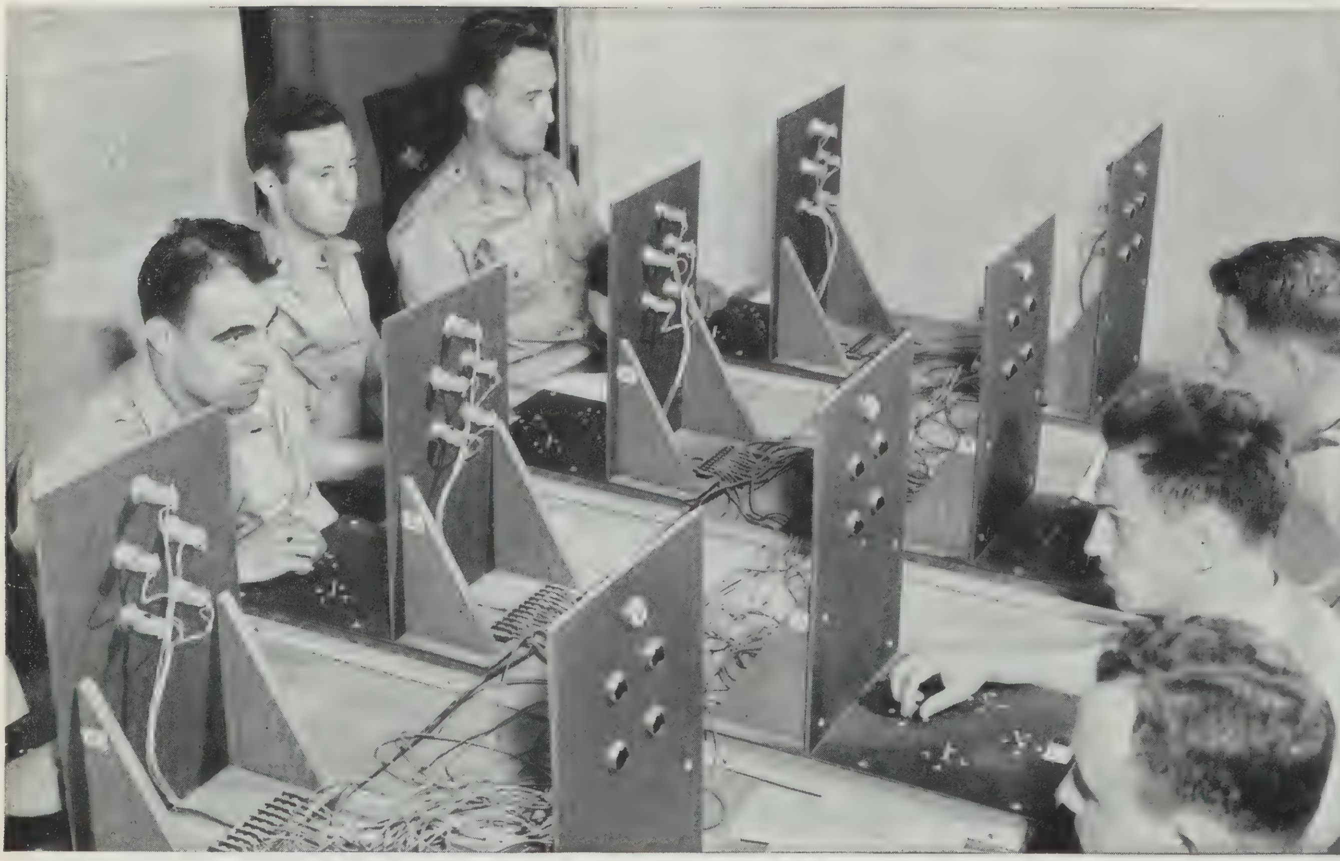
Two instruments whose validity is now a matter of empirical fact are employed in selecting and classi-

fying aircrew applicants. The first device, the *Army Air Forces Qualifying Examination* (previously designated the Aviation Cadet Qualifying Examination), is used primarily to screen out those who lack the necessary qualities to assimilate training in any one of the aircrew specialties. This test has been revised frequently as data on the effectiveness of various types of material for predicting aircrew success became available. The latest form includes tests of reading comprehension, general aviation information, automobile driving information, judgment, mechanical comprehension, and perceptual ability. This test is of the paper and pencil type and may be administered to large groups. It is administered by Aviation Cadet boards to all applicants for aircrew training. A minimum qualifying score which is achieved by approximately 50% of all applicants is employed.

The Army Air Forces Qualifying Examination is used, therefore, as a purely selective device, screening out those individuals whose chances of success are low. The other device, the *Psychological Classification Test Battery,* is used for both selection and classification. Those applicants who qualify on the Army Air Forces Qualifying Examination are tested with the Classification Test Battery at the AAF basic training centers. The battery is administered by specially trained enlisted men under the supervision of aviation psychologists who maintain uniform testing conditions in all of the testing units.

This battery is composed of 18 tests. Each of these tests has proved validity for pilot training, bombardier training, or navigator training. The battery was developed through careful investigations of the aptitudes required for success in one or another of these forms of training, the development of tests to meas-

Two Hand Coordination Test. Both hands are used simultaneously on two lathe type handles to follow target moving in an irregular path.



Discrimination Reaction Time Test. Candidates react to four different positions of a red light and green light by pushing one of four switches.

ure these aptitudes, and the validation of those tests against actual performance in training. Twelve of the tests are paper and pencil tests which can be administered to large groups in one day. Some of the aptitudes which these tests are believed to measure are intelligence, judgment, perceptual alertness, personality, and interest. Six tests are individual apparatus tests which measure accuracy and promptness of response, coordination, and similar aptitudes. Some of these tests provide bases for the prediction of pilot success, some of navigator success, and some of bombardier success. Some of them give very accurate bases for prediction and some only fairly accurate ones. The scores on the tests are weighted with these facts in mind and put together in 7 composite aptitude scores for aircrew training. Each man who takes the battery of tests is thus given 7 scores which may be used to predict his chances for success as a fighter pilot, a bomber pilot, a bombardier, a navigator, a radio operator gunner, a mechanic gunner, or a career gunner. The aptitude scores are expressed in terms of a standard 9-point scale, ranging from 1 (lowest) to 9 (highest) and are called stanines. The scale is based upon a unit of half a standard deviation, the highest 4% of the group of men who take the battery receiving a stanine of 9, the middle 20% receiving a stanine of 5, the lowest 4% a stanine of 1, etc.

The employment of the stanine scores in selection is carried out by assigning minimum qualifying stanine scores for each of the aircrew specialties. These qualifying scores are established by Headquarters, AAF, and are based upon quota requirements, procurement policies, and upon the minimum aptitude required for success in military aviation. During the latter part of 1944, to qualify for pilot training, an applicant was required to earn a fighter pilot stanine or a bomber pilot stanine of 6. Qualification for bombardier training was on the basis of a bombardier stanine of 6 while a navigator stanine of 7 was required for navigator training. These requirements are subject to change. Standards for B-29 gunners were higher than standards for other gunners.

Those men who fail to reach a minimum qualifying

score for any of the aircrew officer specialties are assigned to other forms of training. Those who qualify for only one type of aircrew training are recommended for classification in that training. For those who qualify for more than one type of training, recommendation for classification is based upon the relative values of the qualifying stanines and, where possible, upon the preference expressed by the applicant. Classification, therefore, depends upon preference as well as aptitude; data demonstrates that, other things being equal, a man's chances of success in a form of training which he desires are greater than in a form of training which he does not prefer. The fighter pilot-bomber pilot differentiation is not made at the basic training center where the testing is performed, nor at the preflight school where final assignment is made. All those classified as fighter or bomber pilots will receive the same training through preflight, elementary, and basic training. At the end of basic training, however, it is planned to employ the fighter and bomber pilot stanines in conjunction with height and weight requirements in determining which type of advanced training the individual will undergo.

Complex Coordination Test. Positions of red and green lights in each row are matched by moving controls.

Rudder Control Test. Cockpit is kept lined up on target by applying pressure on the rudder pedals.

Rotary Pursuit Test. Following a revolving target with a stylus and depressing one of two light buttons.

A demonstration of the effectiveness of the pilot stanine (since the differentiation of fighter and bomber pilot stanine is a recent development for predicting success in elementary flying, no data concerning it are yet available) is shown in the chart, based on the scores of 152,933 men who entered elementary pilot training. It will be observed that only 4.5% of those who received a stanine of 9 were eliminated while 79% of those who received a stanine of 1 were eliminated. (The men in this group with low stanines were sent into training early in the war, before the present classification standards were established.) If all men who had a stanine below 6 had been disqualified, 70% of all the eliminees would have been discarded while only 37% of all the graduates would have been lost. This represents a very valuable saving in man-hours, money, and equipment. Similar data on groups entering bombardier and navigator training are shown in the charts on the following page.

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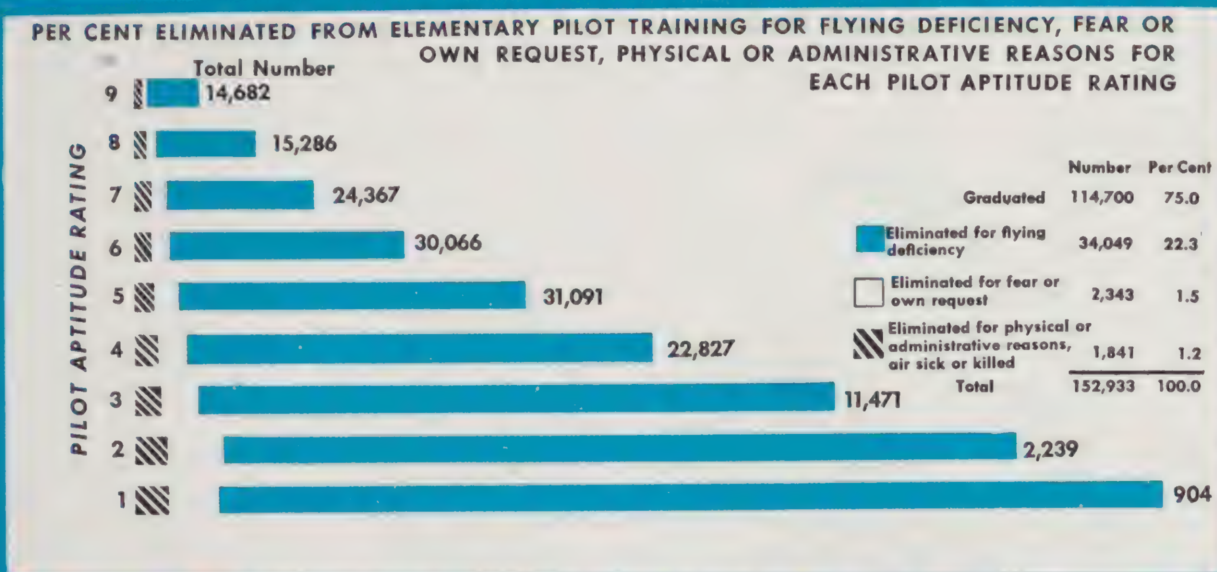
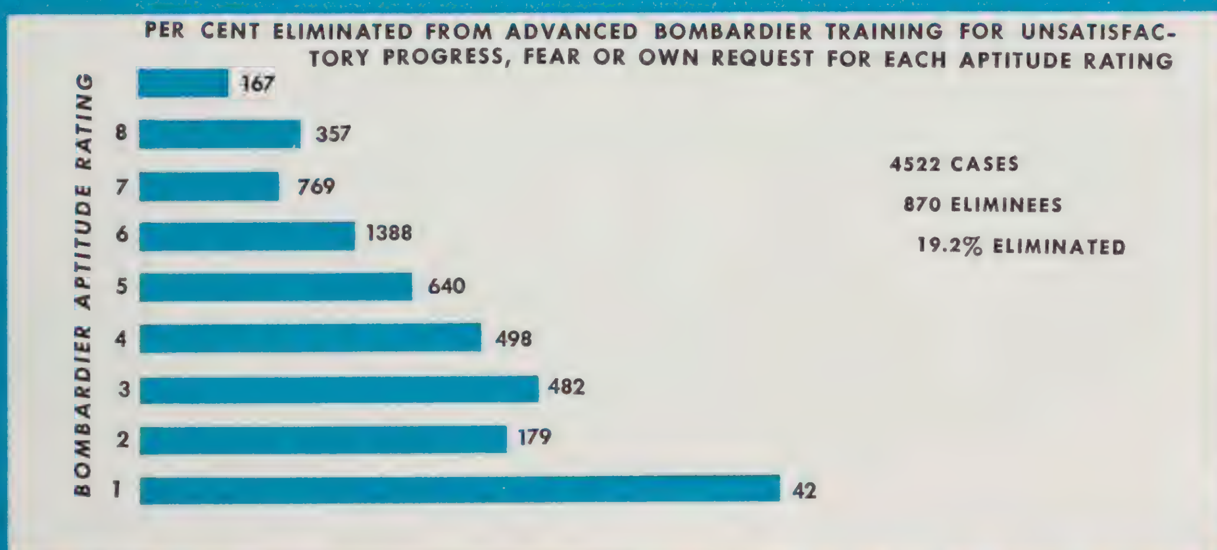
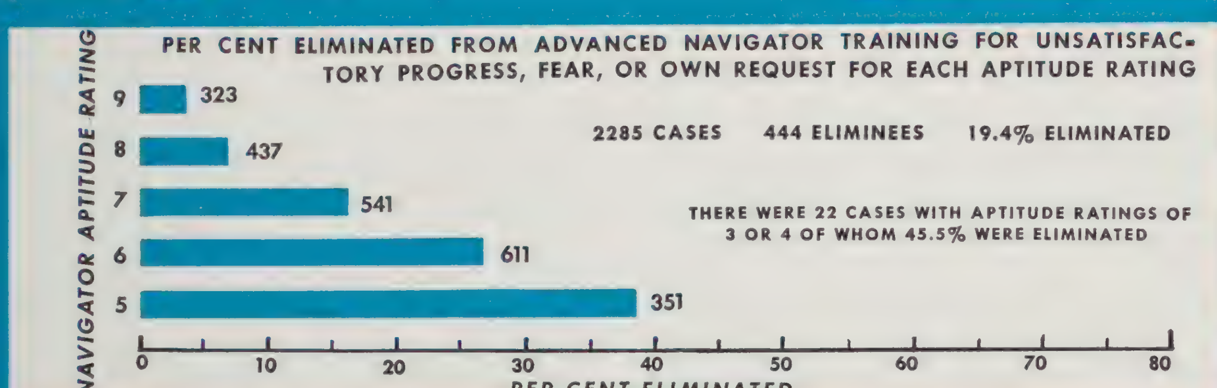
Finger Dexterity Test. Candidate is required to lift, turn, and to replace pegs in a board.


PER CENT ELIMINATED FROM ELEMENTARY PILOT TRAINING FOR FLYING DEFICIENCY, FEAR OR OWN REQUEST, PHYSICAL OR ADMINISTRATIVE REASONS FOR EACH PILOT APTITUDE RATING
Total Number
PILOT APTITUDE RATING
9 14,682
8 15,286
7 24,367
6 30,066
5 31,091
4 22,827
3 11,471
2 2,239
1 904
Number Per Cent
Graduated 114,700 75.0
Eliminated for flying deficiency 34,049 22.3
Eliminated for fear or own request 2,343 1.5
Eliminated for physical or administrative reasons, air sick or killed 1,841 1.2
Total 152,933 100.0


PER CENT ELIMINATED FROM ADVANCED BOMBARDIER TRAINING FOR UNSATISFACTORY PROGRESS, FEAR OR OWN REQUEST FOR EACH APTITUDE RATING
BOMBARDIER APTITUDE RATING
167
8 357
7 769
6 1388
5 640
4 498
3 482
2 179
1 42
4522 CASES
870 ELIMINEES
19.2% ELIMINATED


PER CENT ELIMINATED FROM ADVANCED NAVIGATOR TRAINING FOR UNSATISFACTORY PROGRESS, FEAR, OR OWN REQUEST FOR EACH APTITUDE RATING
NAVIGATOR APTITUDE RATING
9 323
8 437
7 541
6 611
5 351
2285 CASES 444 ELIMINEES 19.4% ELIMINATED
THERE WERE 22 CASES WITH APTITUDE RATINGS OF 3 OR 4 OF WHOM 45.5% WERE ELIMINATED
0 10 20 30 40 50 60 70 80
PER CENT ELIMINATED

THE PSYCHOLOGICAL AND NEUROPSYCHIATRIC EXAMINATION

In selection of the flyer, it is necessary that the flight surgeon be familiar with the technique and interpretation of the psychological and neuropsychiatric study in order that he may make an "Adaptability Rating for Military Aeronautics." This rating has long been considered the result of a *psychological* examination but in reality it is the result of a *psychiatric* as well as other examinations and represents an over-all estimate of the individual based on somatic as well as psychic findings. With that thought in mind the flight surgeon should be able to readily divorce himself from another prevalent misconception, which is that the primary purpose of this examination is to determine whether or not a given individual can *learn* to fly. This particular misconception has done more to defeat the potential value of this examination than any other factor. It is the duty of the *psychologist* to predict success in flying training, and this is a duty which the psychologist has performed creditably (see Section 7-5). It is the duty of the flight surgeon, functioning as a *psychiatrist,* to determine whether or not an individual should fly regardless of his ability to learn to do so, and to predict insofar as possible how useful he will be in combat aviation. It will be recognized that the examination for selection described here is equally applicable to the flyer seeking guidance and to the flyer referred for neuropsychiatric study.

Technique of examination

The tool of this examination is the interview. The interview must be conducted in a quiet, friendly manner in surroundings of privacy and comfort. Although the examination is formal, it must be conducted informally. In general, the taking of notes, filling out of forms, etc., is to be discouraged during the actual interview. The examiner with a good memory has a distinct advantage, for any of the above procedures tend to make the subject more reticent and inaccessible. Abrupt, blunt questioning is uniformly unsuccessful. Questions must be carefully and intelligently worded and should not be framed in such a way as to permit a "Yes" or "No" answer. The opportunity to give such an answer blocks any further approach to that particular subject, and does not permit what might be termed a "probing" of the total personality.

The success or failure of this type of examination depends very largely upon the degree of rapport that the examiner is able to establish with the applicant. The applicant is logically on guard and suspicious in such a situation. It is the duty of the examiner to establish the proper transference by evidence of sympathetic understanding and interest so that the applicant's defenses may be broken down and his innermost thoughts revealed. The examiner must be particularly careful not to identify with those applicants he "likes" and consequently overlook their unfavorable qualities. He must likewise be careful not to project on those he "dislikes" and be correspondingly severe. Should a clash of personalities be evident, or become apparent as the examination progresses, it is advisable to terminate the interview and turn the applicant over to some other examiner.

During the course of the interview it is expected that any unusual mental conflicts, morbid fears, phobias, etc., will be elicited. Therefore information should be sought with a view to evaluating the family history, the environment during the formative years, intelligence, psychomotor activity and achievement, emotional content and stability, and somatic demands with particular reference to evidences of instability and lack of control over these demands.

To elicit the information suggested above satisfactorily it is necessary for a chronological life history of the applicant to be obtained. The method of doing this will necessarily vary considerably among examiners. No aspect of the examinee's life must be ignored, and no time left unaccounted for. During the interview objective reactions as described at the end of the following list of questions should be noted.

Suggested Inquiries. The list of questions presented here is intended only as a guide with the thought that it may suggest the type of information to be sought. As has been indicated, this list, and no other list, must never be employed in the manner of a questionnaire. Each examiner will have to develop his own technique in covering the points below:

1. What is your age? The ages of your brothers and sisters?
2. Where did you live as a child: farm, town, city?
3. What was your father's occupation?
4. Have your parents always lived together? If not, why not?
5. Has there been or is there now any nervous breakdown in your family?
6. Has any member of your family ever been a resident of a mental hospital?
7. Has there been any suicide in your family?
8. Has any member of your family frequently used alcohol excessively?
9. What was the financial status of your home: poor, average, better than average?
10. How old were you when you finished high school?
11. What failures did you have in the grades or in high school?
12. How much college work have you accomplished?
13. What colleges have you attended?
14. What failures have you had in your college work?
15. As a student have you been on the whole: superior, better than average, average, below average?
16. What has been the goal of your education?
17. In what activities did you participate in high school and college aside from academic school work?
18. When did you stop going to school or college?
19. Why did you stop going to school?
20. Who financed your education?
21. What particular skills or ability do you have?
22. What jobs have you had and for how long?
23. How many years and months have you been unemployed since out of school?
24. What hobby do you have?
25. Does anyone have it in for you—a real enemy?
26. During the past 5 years how many fights have you had?
27. What major disciplinary actions have been taken against you, as expulsion from school, military discipline, civilian arrests?
28. How many auto accidents have you had? In

how many of these were you the driver? How often have you been arrested—for what reasons?

29. How do you get along with girls; enjoy their company, indifferent, avoid them?

30. How many romances have you had (steady girl for weeks or months)?

31. Have you ever been married?

32. What illnesses have you had that were so severe that you were out of your head or delirious?

33. Did you ever stammer or stutter? Are you left handed?

34. Have you had any periods of unconsciousness due to accident, injury, or being knocked out? Duration of such periods?

35. Have there been any instances of fainting? Give age and circumstances?

36. Have there been any instances of walking in your sleep? Give age and place.

37. Do you have headaches? Frequently, rarely, never?

38. Have you ever taken medicine to help you get to sleep?

39. Have you ever been wakened by frightening dreams? If so, when?

40. How old were you the last time you wet the bed (urinated) while asleep?

41. Have you ever had any fits or convulsions?

42. Do you get the "blues": frequently, seldom, never?

43. Of what things are you afraid?

44. How many cigarettes or pipefuls of tobacco do you smoke a day?

45. How much liquor do you use: frequently drunk, occasionally drunk, occasional social drink, occasional beer, none?

46. Is there any period of your life that is blank to you—of which you have no memory—for 15 minutes, half an hour, or longer?

47. Have you had any previous military service? Army, Navy, Marines, ORC, ROTC, CMTC?

48. What ratings or advancements have you had?

49. How long have you been interested in flying?

50. Why have you wanted to do army flying?

51. How many minutes or hours have you spent flying (student or passenger?) Soaring? Gliding?

52. Have you ever been sick or dizzy in the air?

53. What is the attitude of your parents toward your flying: enthusiastic, content, opposed?

Objective Reactions to be Noted. The following reactions should be noted during the interview, and correlation attempted between their occurrence and precipitating stimuli if possible: Facial expression, postures, attitudes, tenseness; motor movements such as gait, gestures, restlessness and fidgetiness; tears, blushing, mottling of extremities, sweating, tachycardia, fluctuations of blood pressure, sighing, tremor, pupillary dilation, obvious embarrassment, lack of poise, obvious uneasiness, speech defects, nail biting, tics and mannerisms. The correlation of the occurrence of any of the foregoing with any specific stimulus may offer a valuable clue for the obtaining of further pertinent information.

Unfavorable findings and evidence of instability

1. History of multiple (2 or more) instances of mental disturbances in the family.

2. Intelligence is considered below the required standard because of:

a. Many failures in the grades and high school, requiring extra months or years to complete high school.

b. Inability to accomplish college work because of many academic failures.

c. Complete lack of accomplishment to date, and failure to take advantage of opportunities (school and work).

d. Specific instances of applicant's behavior indicating questionable intelligence. Record must be made of evidence demonstrating poor judgment, poor comprehension, poor memory, poor attention, poor learning, or other faulty intellectual operations. These must be so obvious that they outweigh any educational attainments.

3. Multiple (2 or more) instances of somnambulism after the age of 10 years or somnambulism within the year preceding the examination.

4. Severe, repeated pavor nocturnus persistent to the time of the examination.

5. Severe or prolonged insomnia.

6. Repeated enuresis past the age of 10 years.

7. Tic, severe habit spasm or marked mannerism.

8. Stammering or stuttering having its onset after the age of 10 years or persisting beyond the age of 10 years regardless of the examinee's ability to speak at the time of the examination.

9. Epilepsy or convulsions of any type at any time during the examinee's life.

10. Migraine or migrainous type of headache occurring repeatedly and of sufficient intensity as to temporarily incapacitate the examinee for his usual pursuits, or to require regular medication.

11. Psychogenic amnesia.

12. Excessive, habitual use of alcohol.

13. Multiple faints (2 or more) except when these are caused by pain following a severe injury, occur during convalescence from an acute infection or severe illness, or result from loss of blood.

14. Combinations of the following: Marked tension, excessive sweating, blushing, blanching, nail biting, crying and timidity. The foregoing and all other manifestations of *vasomotor instability* may be considered as evidence of *emotional instability*. Similarly, a history of unusual emotional responses such as an unusually severe depression of mood following the death of a member of the family may be so considered.

15. Obsessions, compulsions or phobias of sufficient degree to materially motivate and influence behavior.

16. Any major psychosis or history thereof.

17. Any psychoneurosis or history thereof.

18. Constitutional psychopathic state.

19. Major abnormalities of mood, excessive schizoid trends, sexual aberrations, criminalistic tendencies and excessive irritability or suspiciousness.

The adaptability rating for military aeronautics (ARMA)

The majority of applicants for flying training will be found to be qualified for flying within the purview of this examination. This examination may provide the only reason for disqualifying an applicant, but such a disqualification is as valid as disqualification for any physical defect. Such a disqualification should be supported by adequate reasons but remarks which are personally offensive to the applicant, or which may be controversial should not be entered on WD AGO Form 64. Thus, a homosexual may be described as an "arrested personality development," an intellectually inferior individual as "poor achievement," etc. In most instances disqualifications on this examination will be supported by physical evidences of instability.

Scoring. The following suggestions for scoring the ARMA are offered as a guide:

A theoretically perfect score is considered to be 200 points. Scores above 160 are qualifying, those below that figure disqualifying. While the assignment of numerical values to personality traits has many objections, the following numerical values for certain findings are suggested in order that there may be a uniform system of evaluation. The smallest figure represents the minimum amount to be subtracted from 200 if that particular condition exists, and the largest figure the maximum if the unfavorable finding exists in marked degree. It can be seen that if an applicant has two conditions, the minimum sum of which is 40, he is automatically disqualified, as he cannot be assumed to be perfect in all other respects. Similarly, in those instances in which the maximum value for an unfavorable trait is 40, that condition may be disqualifying in itself. The examiner must exercise his judgment in assigning values to other conditions not specifically mentioned which may influence qualification or disqualification. Evidence of marked vasomotor instability and other emotional phenomena, for example, will be given special unfavorable consideration particularly if occurring in conjunction with some other condition.

Suggested numerical values to be deducted from total score:

(10-20) Nervous and mental disease in family (each instance)

(10-20) Alcoholism in family (each instance)

(10-20) Criminality in family (each instance)

(5-10) Insomnia in applicant (persistent)

(20-40) Hay fever, asthma or other allergic phenomena

(10-40) Enuresis (prolonged)

(20-40) Somnambulism

(5-40) Alcoholism

(15-40) Fainting (inadequate)

(12-40) Unconsciousness (duration and cause)

(40) Fracture of skull or severe concussion (see AR 40-110)

(5-40) Phobias and obsessions (excessive fears)

(10-20) Nail-biting

(20-40) Amnesia

(20-40) Fits, spasms and convulsions

(10-40) Speech defects (corrected or uncorrected)

(10-40) Chorea, poliomyelitis, encephalitis, meningitis

(10-40) Arrests

Probably relatively few applicants will be disqualified who do not have some positive findings in the above list, although final decision may be influenced by other factors in each individual case.

Neurological examination

The neurological examination is to be conducted in accordance with MR1-9 and with standard texts of neurology. The WD AGO Form 8-49 may be used as a guide in conducting this examination, especially when neurological disease is suspected.

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SECTION 8

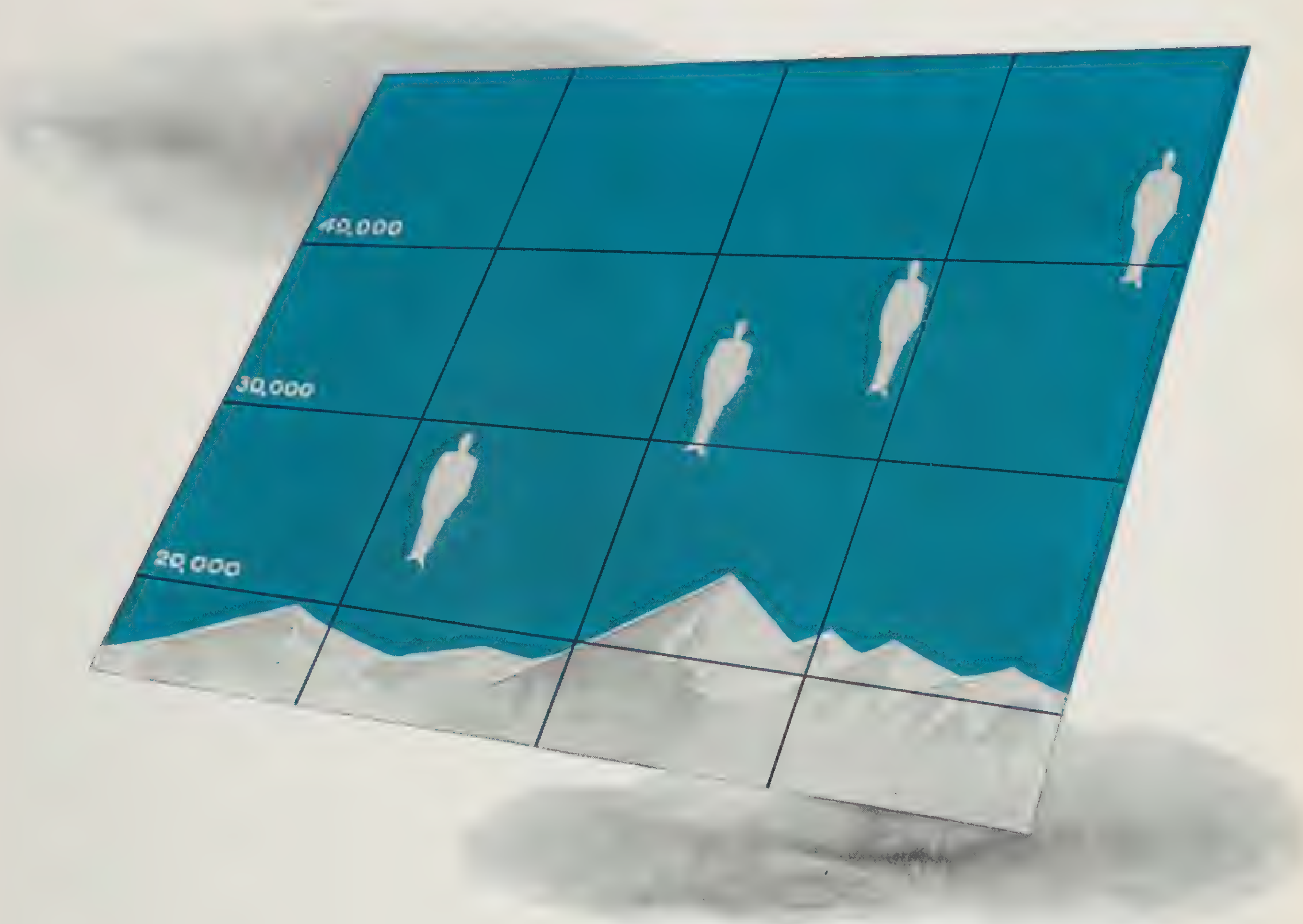
CARE OF THE FLYER

SECTION 8

CARE OF THE FLYER

1. Effects of Decreased Partial Pressure of Oxygen (Anoxic Anoxia, Altitude Sickness).
2. Effects of Decreased Barometric Pressure (Decompression Sickness).
3. Effects of Changing Barometric Pressure.
4. Effects of Temperature.
5. Effects of Motion.
6. Effects of Noise.
7. Effects of Parachute Descent.
8. Standard Procedure in the Crash.
9. Injuries in Aircraft Accidents.
10. Noxious Gases and Vapors in Aircraft.
11. Anxiety Reactions in Airmen (Operational Fatigue).
12. Night Vision.
13. Drugs and the Flyer.

EFFECTS OF DECREASED PARTIAL PRESSURE OF OXYGEN



(ANOXIC ANOXIA, ALTITUDE SICKNESS)

Definitions

Altitude sickness in aviation is a syndrome which is usually acute, and results from inadequate oxygenation of tissues secondary to a decreased partial pressure of oxygen in the inspired air. A synonym, *anoxia,* meaning literally "without oxygen," is used physiologically to denote a deficiency rather than a lack of oxygen in the tissues. A more correct term is *hypoxia,* for in most cases of acute altitude sickness the tissues are probably never entirely without oxygen. Both terms are to be differentiated from *anoxemia* and *hypoxemia* which mean literally and respectively absence of oxygen from and decrease of oxygen in the blood.

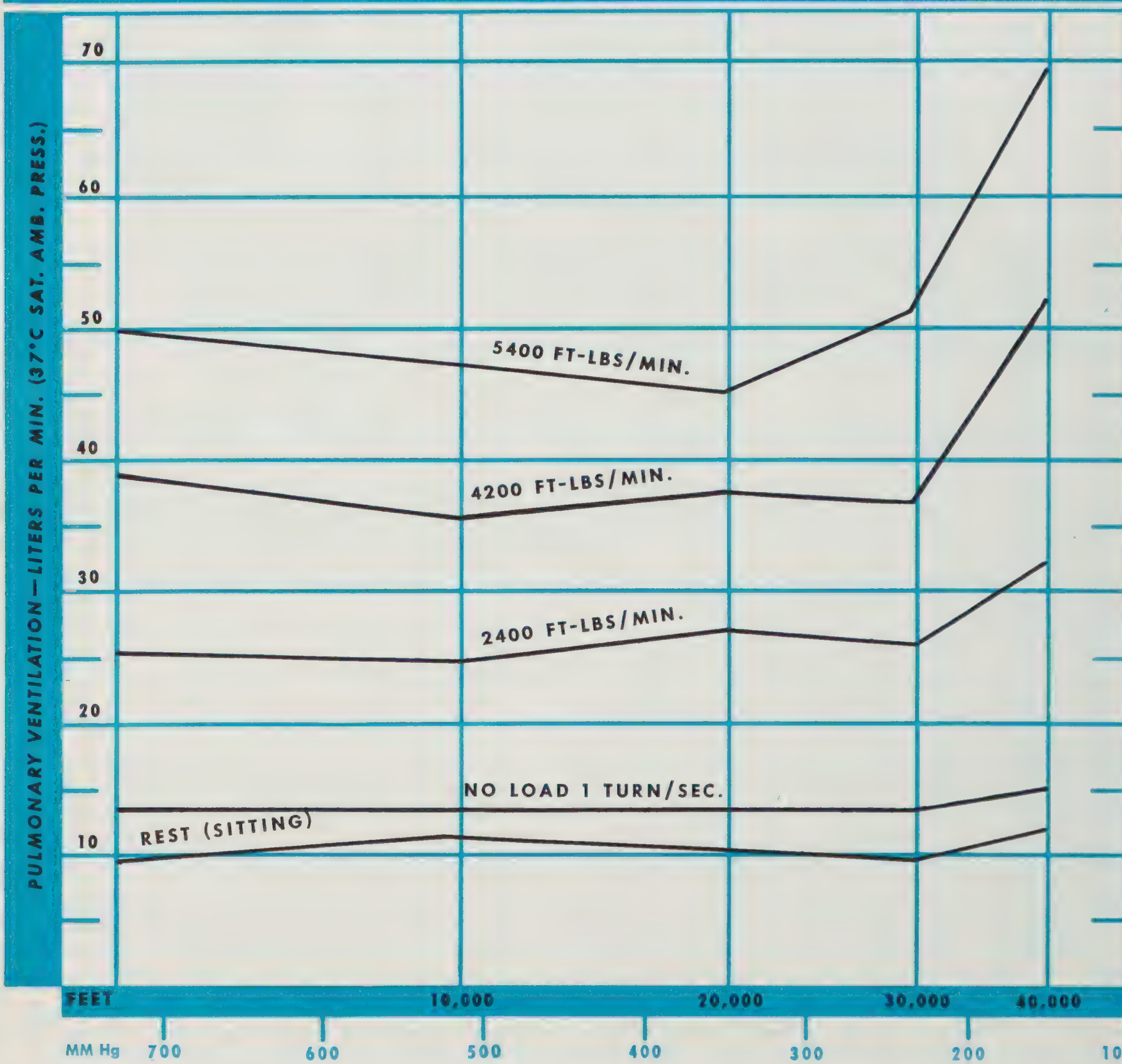
Respiration may be defined as the relation between an organism and the gases in its environment. In man it may be considered as *external* and *internal.*

External respiration involves the exchange of gases between the blood in the capillaries of the lungs and the external air as found in the pulmonary alveoli. Internal respiration is the exchange of gases between the blood in the capillaries and the body's tissue cells.

External respiration

The volume of air inhaled and exhaled with each breath ("tidal air") averages about 500 cc for a man at rest. The volume of air breathed per minute ("ventilation rate") for the average individual at rest amounts to 6 to 8 liters. The ventilation rate, adjusted to the needs of the body, is increased greatly by work. The figure shows the relationship between ventilation rate and work rate at altitudes up to 40,000 feet while the subject breathes through a demand oxygen system. The ventilation rate does not change with altitudes up to 30,000 feet. Measure-

THE RELATION OF PULMONARY VENTILATION RATE TO WORK RATE.



ments of ventilation rates of bomber crews and pursuit pilots during flight show a range of 7.3 to 26.5 liters per minute during periods of inactivity, the average rate being 13.9 liters per minute. When the subjects are active, rates range from 6.3 to 64 liters per minute, with an average of 24.8 liters. Highest ventilation rates are found in waist gunners, and rates of decreasing magnitudes are found in crew members as follows: tail gunner, nose gunner, bombardier, top turret gunner, pursuit pilot, bomber pilot, and copilot.

The volume of air which can be exhaled from the lungs by the deepest possible exhalation after the deepest possible inhalation ("vital capacity") represents the maximum value to which the tidal volume may be increased.

Of the 500 cc taken into the respiratory system with each inspiration, the last 140 cc or 150 cc never reach the alveoli, for this is the volume of air necessary to fill the respiratory passages leading from the

DIVISIONS OF RESPIRED AIR

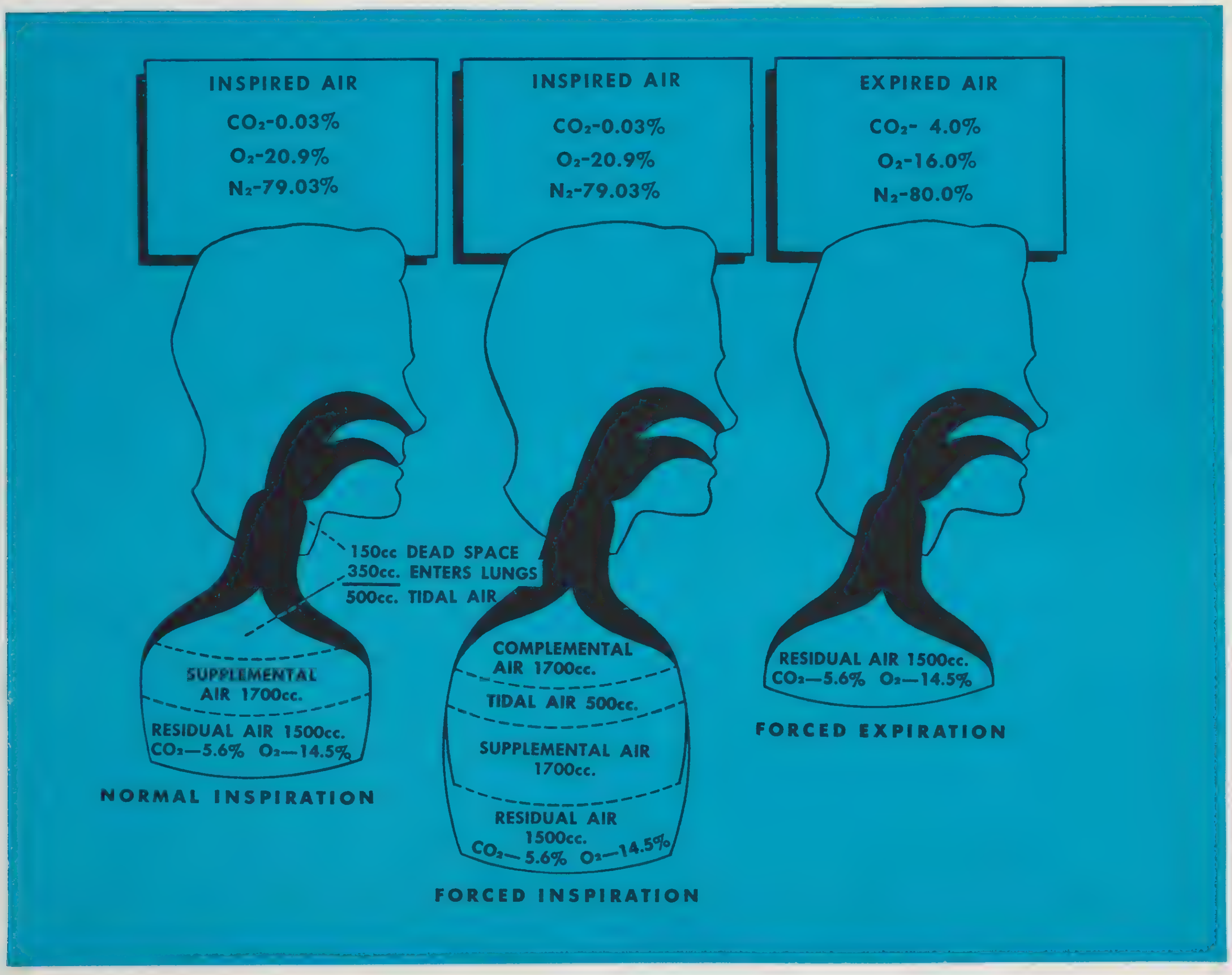
DEFINITIONS—

Tidal Air—Air which enters and leaves body with each normal respiration.

Supplemental Air—Air which can be forcibly expired after a normal tidal expiration.

Complemental Air—Air which can be forcibly inspired after a normal tidal inspiration.

Residual Air—Air which cannot be voluntarily expelled from lungs.

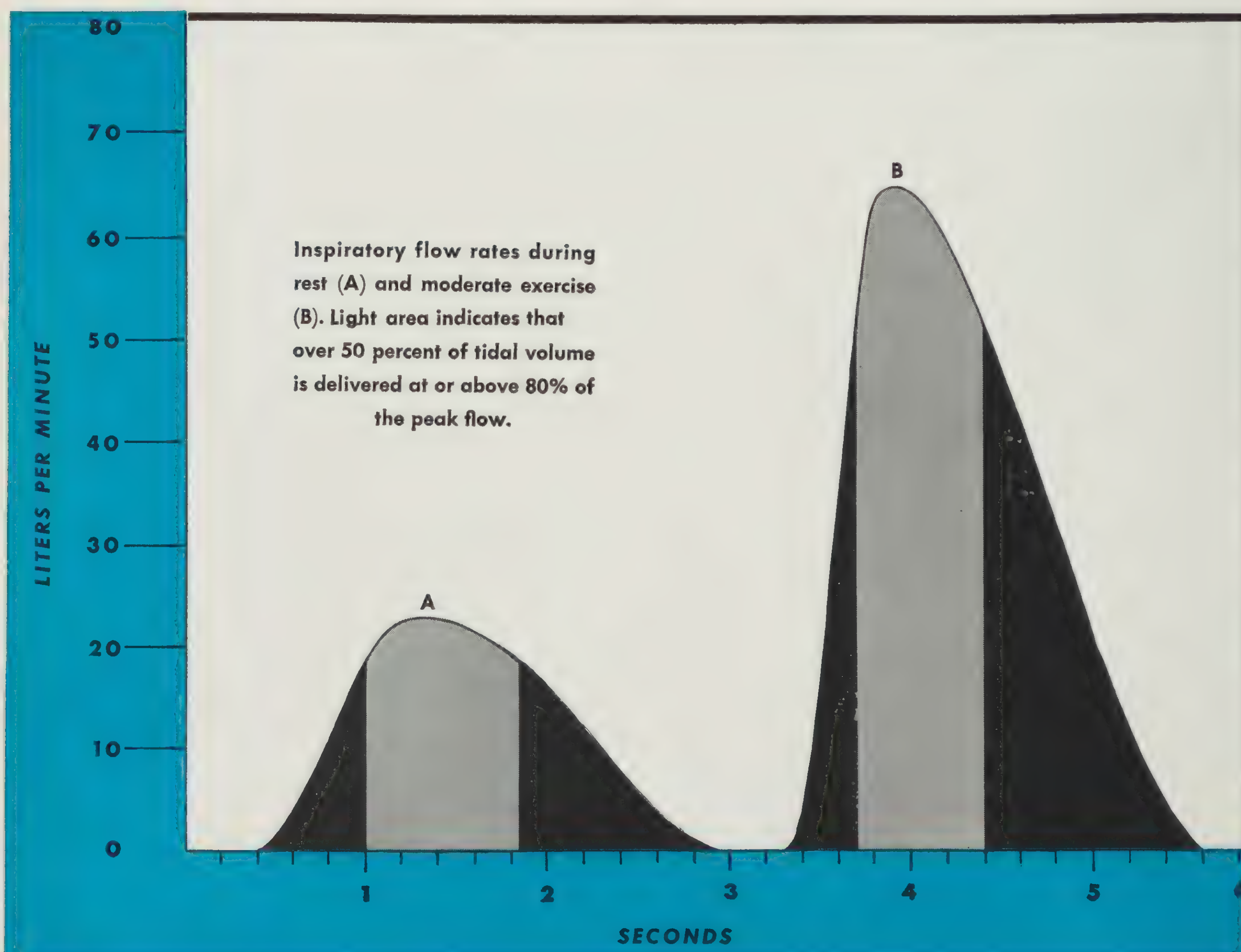


nose to the alveoli ("dead space"). It is the first air to emerge on exhalation, and, when analyzed, its gaseous composition is not appreciably different from outside air. The remainder of the tidal air mixes with the gases in the alveoli. The composition of alveolar air ordinarily remains constant at ground level.

During a single inspiration of a resting individual the "instantaneous flow rate" increases from none at the beginning to 20 or 30 liters per minute near the midpoint of inspiration and returns to none at the end. An individual who is exercising moderately may have a minute-volume ventilation of 25 to 45 liters per minute and an instantaneous flow rate as high as 65 to 90 liters per minute. In general, to obtain the maximal inspiratory or peak flow rates, minute-volume ventilation (stated at standard conditions of temperature and pressure) may be multiplied by approximately 3.7 when the subject is at rest and by 2.8 when the individual is exercising.

Respiratory curves of man show that 55% of the tidal volume is delivered at or above 80% of the peak flow during rest and 53% is delivered during moderate exercise. A significant portion of the tidal volume of some subjects may be delivered at relatively low flows. The practical significance of these facts is that demand oxygen regulators must be constructed to deliver oxygen smoothly and without any great inspiratory effort at low as well as at high rates of flow.

Composition of respired air. Dry atmospheric air by volume contains 29.94% oxygen, 79.03% nitrogen, and 0.03% carbon dioxide. Included with the nitrogen are small amounts of rare gases which have no physiological significance. The relative composition of dry atmospheric air does not vary appreciably



Inspiratory flow rates during rest (A) and moderate exercise (B). Light area indicates that over 50 percent of tidal volume is delivered at or above 80% of the peak flow.

with altitudes up to 70,000 feet. There are no significant variations with latitude.

To express quantities of gas at various altitudes by percentages of the atmosphere means little physiologically, for percentage represents the relative volume of a gas and not its molecular concentration. Since molecular concentration determines the availability of the gas to the body, the actual concentration of any gas can be expressed better in terms of "partial pressure."

A quantity of gas mixed with other gases exerts the same pressure that it would if the other gases were not present. The "total pressure" of a mixture of gases is, therefore, the sum of the pressures of the individual gases comprising the mixture (Dalton's law). For moist air this can be represented by the formula:

$$B = pO_2 + pN_2 + pCO_2 + pH_2O$$

where B is total barometric pressure, and pO_2, pN_2, pCO_2, and pH_2O are the partial pressures of oxygen, nitrogen, carbon dioxide, and water, respectively.

The total pressure (barometric pressure) of the atmosphere at sea level is 760 mm Hg (14.7 psi). Assuming that the air is dry, the partial pressure exerted by oxygen at sea level is $\frac{20.94}{100} \times 760 = 159$ mm Hg (3.1 psi). The partial pressure exerted by nitrogen at sea level is $\frac{79}{100} \times 760 = 601$ mm Hg (11.6 psi). The partial pressures of the other gases are similarly calculated.

Composition of pulmonary air. The atmospheric air that is drawn through the nasal passages into the trachea becomes saturated with water vapor. Further, it mixes with air already in the lungs. Hence, samples of expired air contain less oxygen and more carbon dioxide than does inspired air. Expired air does not give a true picture of the conditions that exist in the alveoli, since it is a mixture of air from the alveoli and from the dead space. The partial pressure of oxygen in the alveoli is the significant factor for the body, for it is this measure that determines how much oxygen reaches the blood. The partial pressures of the gases in the alveoli at sea level and at various altitudes when breathing air and when breathing 100% oxygen are shown in the table. When a man is breathing pure oxygen, the partial pressure of oxygen in the alveoli at 33,700 feet is the same as at sea level when breathing air. Above 34,000 feet the partial pressure of oxygen in the lungs begins to fall below that found at sea level, even though 100% oxygen is breathed. At altitudes of more than 40,000 feet, the partial pressure of oxygen decreases rapidly and falls below the limit which permits enough oxygen to be absorbed by the blood to maintain the body in a physiologically safe condition.

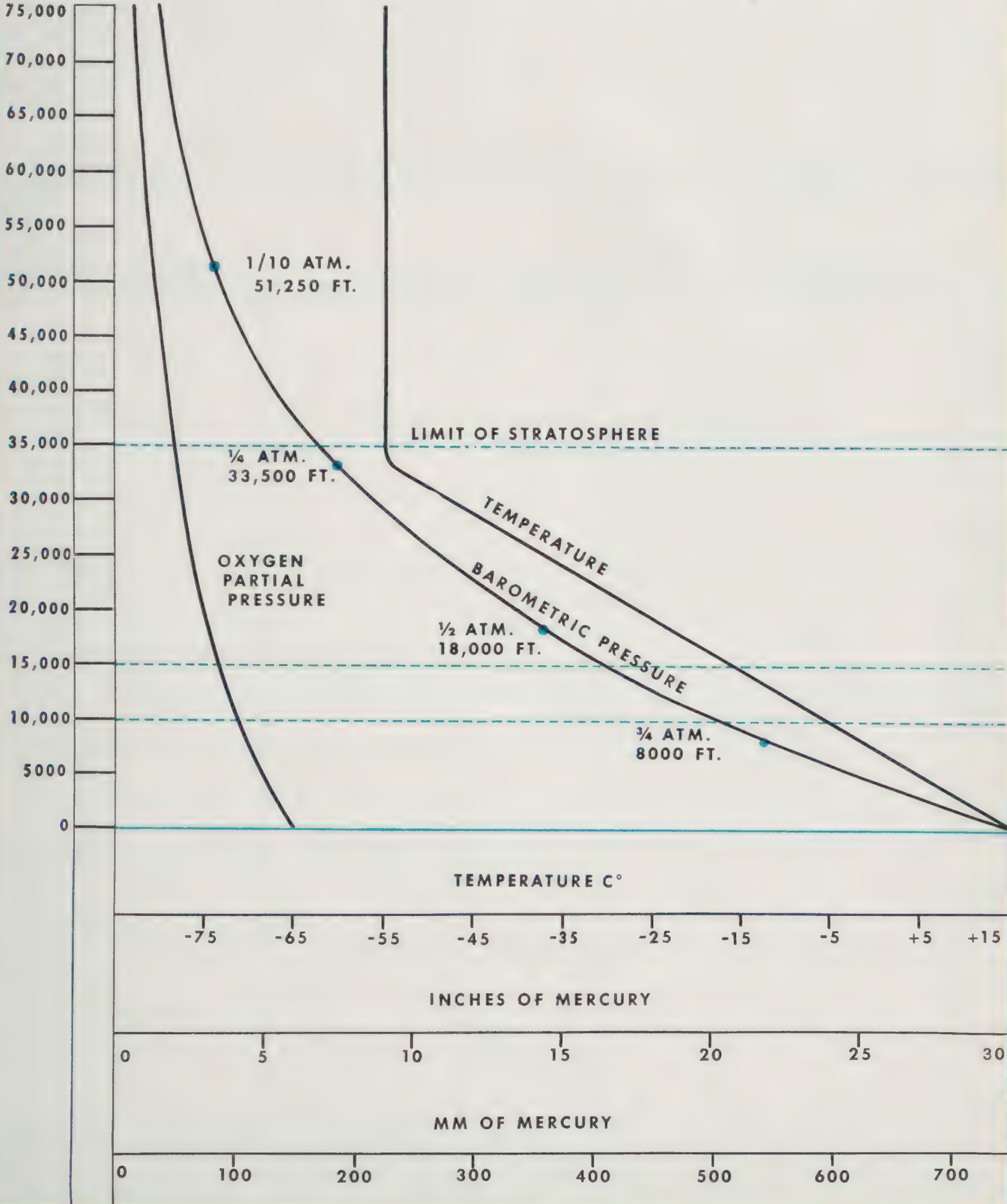
Whereas the pressure of oxygen in the alveoli varies with the percentage of oxygen in the inspired air and the total barometric pressure, and is, consequently, subject to variation as either of these two factors change, the partial pressures of carbon dioxide and water vapor in alveolar air show a tendency to constancy. The tension of alveolar carbon dioxide decreases slightly at altitude but alveolar water vapor maintains a constant tension of 47 mm Hg. As the total pressure in the lungs falls with increasing altitude, the carbon dioxide and water vapor in the lungs attain a proportionately larger volume at the expense of oxygen and nitrogen. Hence, at sea level, carbon dioxide and water vapor, possessing a combined pressure of 87 mm Hg, take up $\frac{87}{760}$ of the total volume in the lungs. At 18,000 feet, where the total pressure is reduced by one-half and the carbon dioxide is reduced slightly, the proportionate volume is approximately $\frac{78}{360}$; and at 38,500 feet it is approximately $\frac{83}{152}$. This increasing fraction with altitude leaves less and less "room" for oxygen and nitrogen, so that a level is finally reached at which it is impossible, even breathing 100% oxygen to maintain a molecular concentration of this gas in the lungs adequate to sustain consciousness or life. This critical "pressure altitude" is about 44,800 feet.

Control of external respiration. Normal breathing, though to a certain extent under voluntary control, is essentially an involuntary act. Regulation of respiratory movements is accomplished at low altitudes by responses of the nervous system to the concentration of carbon dioxide rather than oxygen in the blood. The origin of neural impulses affecting the frequency and depth of breathing is in the respira-

Altitude-Pressure-Temperature Table to Which is Added the Equivalent Oxygen Percent and Partial Pressure (Based on the United States Standard Atmosphere).

Altitude (feet)	Inches of mercury	Pressure Millimeters of mercury	Pounds per square inch	Temperature °C.	Equivalent oxygen percent (dry)	Partial Pressure Oxygen mm Hg
0	29.921	760.0	14.69	15	20.93	159.0
1,000................	28.86	732.9	14.17	13	20.18	153.3
2,000................	27.82	706.6	13.67	11	19.46	147.8
3,000................	26.81	681.1	13.17	9	18.76	142.5
4,000................	25.84	656.3	12.69	7	18.07	137.3
5,000................	24.89	632.3	12.22	5	17.41	132.3
6,000................	23.98	609.0	11.77	3	16.77	127.4
7,000................	23.09	586.4	11.34	1	16.15	122.2
8,000................	22.22	564.4	10.91	-1	15.54	118.1
9,000................	21.38	543.2	10.50	-3	14.96	113.6
10,000...............	20.58	522.6	10.10	-5	14.39	109.3
11,000...............	19.79	502.6	9.72	-7	13.84	105.1
12,000...............	19.03	483.3	9.34	-9	13.31	101.1
13,000...............	18.29	464.5	8.98	-11	12.79	97.2
14,000...............	17.57	446.4	8.63	-13	12.29	93.4
15,000...............	16.88	428.8	8.29	-15	11.81	89.7
16,000...............	16.21	411.8	7.96	-17	11.34	86.1
17,000...............	15.56	395.3	7.64	-19	10.89	82.7
18,000...............	14.94	379.4	7.33	-21	10.45	79.4
19,000...............	14.33	364.0	7.03	-23	10.02	76.1
20,000...............	13.75	349.1	6.75	-25	9.61	73.0
21,000...............	13.18	334.7	6.47	-27	9.22	70.0
22,000...............	12.63	320.8	6.20	-29	8.83	67.1
23,000...............	12.10	307.4	5.94	-31	8.47	64.3
24,000...............	11.59	294.4	5.69	-33	8.11	61.6
25,000...............	11.10	281.9	5.45	-35	7.76	59.0
26,000...............	10.62	269.8	5.22	-37	7.43	56.4
27,000...............	10.16	258.1	4.99	-39	7.11	54.0
28,000...............	9.72	246.9	4.77	-41	6.80	51.6
29,000...............	9.29	236.0	4.56	-43	6.50	49.3
30,000...............	8.88	225.6	4.36	-44	6.21	47.2
31,000...............	8.48	215.5	4.17	-46	5.93	45.1
32,000...............	8.10	205.8	3.98	-48	5.67	43.0
33,000...............	7.73	196.4	3.80	-50	5.41	41.1
34,000...............	7.38	187.4	3.62	-52	5.16	39.2
35,000...............	7.04	178.7	3.46	-54	4.92	37.4
36,000...............	6.71	170.4	3.29	-55	4.69	35.6
37,000...............	6.39	162.4	3.14	-55	4.47	33.9
38,000...............	6.10	154.9	3.00	-55	4.27	32.4
39,000...............	5.81	147.6	2.85	-55	4.06	30.8
40,000...............	5.54	140.7	2.72	-55	3.87	29.4
41,000...............	5.18	134.2	2.59	-55	3.70	28.0
42,000...............	5.04	127.9	2.47	-55	3.52	26.7
43,000...............	4.80	122.0	2.36	-55	3.36	25.5
44,000...............	4.58	116.3	2.25	-55	3.20	24.3
45,000...............	4.36	110.8	2.14	-55	3.05	23.1

PHYSICAL CHARACTERISTICS OF THE STANDARD ATMOSPHERE



tory center of the medulla oblongata. When the tension of carbon dioxide in the blood increases, as it does during exercise, the respiratory center is stimulated and impulses are sent out which increase the rate and depth of respiration. At altitudes of more than 10,000 feet without supplementary oxygen and at altitudes of more than 40,000 feet with 100 per cent oxygen, the reduction in the amount of oxygen in the blood is generally sufficient to cause an increase in the rate and depth of breathing by stimulating the carotid sinus. The increase in rate of ventilation that can be achieved by this mechanism, however, is considerably less than the maximum achieved through the medium of an increase of carbon dioxide in the blood.

Under ordinary circumstances and at ground level,

ALVEOLAR AIR AT EQUIVALENT ALTITUDES BREATHING AIR AND BREATHING 100% OXYGEN

Alveolar Air			Breathing Air		Breathing 100% O_2	
O_2* Tension mm. Hg.	CO_2* Tension mm. Hg.	H_2O Vapor Tension mm. Hg.	Barometric Pressure mm. Hg.	Altitude Feet	Barometric Pressure mm. Hg.	Altitude Feet
103	40.0	47	760	0	190	33,700
81	37.5	47	632	5,000	166	36,000
61	35.5	47	523	10,000	144	39,500
45	32.5	47	429	15,000	125	42,500
38	31.0	47	380	18,000	116	44,000
35	30.0	47	349	20,000	112	44,800

(*Means of measurements made by Lutz and Schneider, and by Boothby, Lovelace, and Benson.)

the relative insensitivity of the respiratory center to anoxia imposes no undue handicap because as the need for oxygen in the cells of the body becomes greater (for example, during exercise), the output of carbon dioxide by the cells likewise increases. It is only because of the close parallel between the rate of production of carbon dioxide and the need for oxygen by the tissues of the body that various oxygen requirements are so well met at ground level.

The situation at high altitudes is different. The partial pressure of oxygen is lowered without any corresponding increase in carbon dioxide. At altitudes between 12,000 and 15,000 feet, the oxygen tension in the blood falls low enough to stimulate the carotid body, producing a reflex rise in ventilation rate. Actually, however, this increase is inadequate. Further, it is of limited value to the body, since it produces a greater loss of carbon dioxide and symptoms such as dizziness, tingling of the extremities, and, if continued long enough, tetanic spasms of the limbs and, possibly, unconsciousness ("hyperventilation syndrome"). This may be of considerable practical significance in flight.

Exchange of alveolar gases. The alveoli form the functionally important part of the respiratory tract; it is within them that the exchange of gases between the body and the environment takes place. Although this exchange must take place through the alveolar wall and the capillary wall, these membranes are so thin that they offer no appreciable resistance to the transfer of dissolved gases. Actually, the blood remains in the capillaries of the lungs only 1 or 2 seconds, a sufficient time for the necessary exchange of gases to be accomplished.

Current knowledge indicates that the exchange of gases between the lungs and the blood takes place by means of physical diffusion and follows the fundamental physical laws governing gases. Gases diffuse from regions of higher partial pressure to those of lower partial pressure. In the alveoli, then, oxygen tends to diffuse into the blood of the pulmonary capillaries and carbon dioxide diffuses in an opposite direction.

Internal respiration

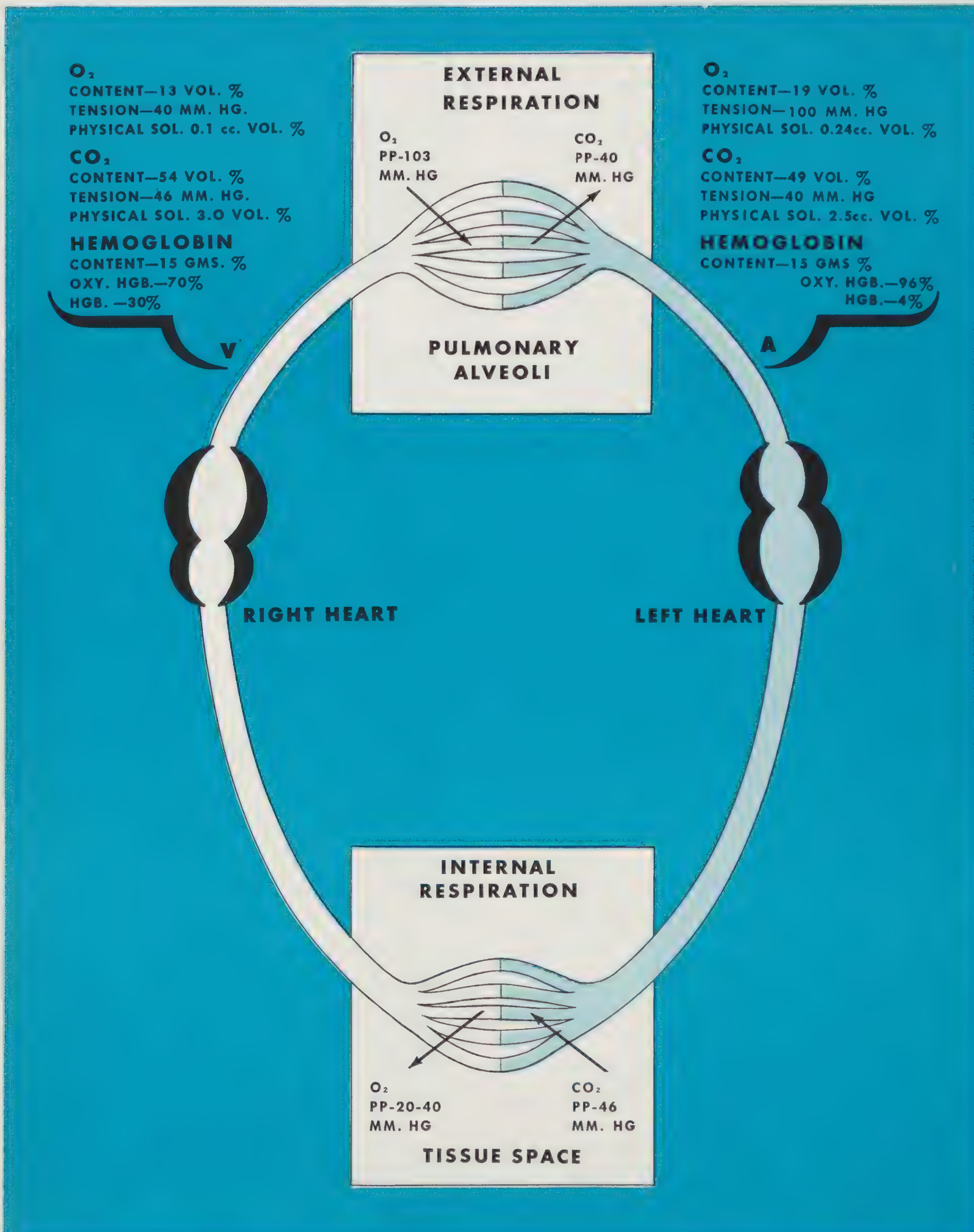
The quantity of gas which goes into solution, temperature remaining constant, is proportional to the partial pressure of the gas concerned (Henry's law). Far greater quantities of oxygen and carbon dioxide are carried in the blood than could be present in simple solution in the plasma. At sea level, when air is breathed, only 0.24 cc of oxygen and 2.5 cc of carbon dioxide are carried in 100 cc of blood in simple solution. Actually, under these conditions 100 cc of blood contain about 18 to 20 cc of oxygen and 40 to 50 cc of carbon dioxide. This is 100 times the amount of oxygen and 20 times the amount of carbon dioxide that would be carried in simple solution. The ability of the blood to carry such a large load of oxygen is due to the hemoglobin contained in the red blood cells. Carbon dioxide is carried largely in the form of bicarbonate ions in the plasma and in the red blood cells.

Oxygen combines reversibly with hemoglobin in a unique manner to form oxyhemoglobin. In the figure, curves of dissociation of oxyhemoglobin may be studied and the following facts noted:

1. The combination of hemoglobin with oxygen is influenced by the partial pressure of oxygen in the surrounding medium. This has a direct effect on the ability of blood to transport oxygen to the tissues of the body at various altitudes.

2. Hemoglobin has a relatively high affinity for oxygen at certain partial pressures of oxygen and a relatively lower affinity for oxygen at lower pressures as shown by the S-shaped curves. The blood has a high capacity for oxygen at the partial pressure of oxygen found in the lungs, and a low capacity at the partial pressure found in the tissues. This leads to a rapid loading of oxygen in the lungs and a rapid unloading in the tissues.

3. The acidity, pH, affects the oxygen-carrying capacity of hemoglobin. Variations in acidity are due largely to variations in the content of carbon dioxide, and this, in turn, to respiratory regulation. Since hemoglobin combined with oxygen is more strongly



O_2
CONTENT—13 VOL. %
TENSION—40 MM. HG.
PHYSICAL SOL. 0.1 cc. VOL. %
CO_2
CONTENT—54 VOL. %
TENSION—46 MM. HG.
PHYSICAL SOL. 3.0 VOL. %
HEMOGLOBIN
CONTENT—15 GMS. %
OXY. HGB.—70%
HGB. —30%
V
EXTERNAL RESPIRATION
O_2 PP-103 MM. HG
CO_2 PP-40 MM. HG
PULMONARY ALVEOLI
O_2
CONTENT—19 VOL. %
TENSION—100 MM. HG
PHYSICAL SOL. 0.24cc. VOL. %
CO_2
CONTENT—49 VOL. %
TENSION—40 MM. HG
PHYSICAL SOL. 2.5cc. VOL. %
HEMOGLOBIN
CONTENT—15 GMS %
OXY. HGB.—96%
HGB.—4%
A
RIGHT HEART
LEFT HEART
INTERNAL RESPIRATION
O_2 PP-20-40 MM. HG
CO_2 PP-46 MM. HG
TISSUE SPACE

acid than when it is free from oxygen, oxyhemoglobin reduces the bases which can combine with carbon dioxide in the blood. Thus, there is a reciprocal relationship between the transportation of oxygen and carbon dioxide. Since carbon dioxide leaves the blood by way of the capillaries in the lungs, arterial blood can carry a larger amount of oxygen than can venous blood. When arterial blood arrives at the tissues where carbon dioxide is produced and transferred to the blood, a relatively greater amount of oxygen must leave the blood for utilization in the tissues. Arterial blood contains, therefore, a relatively larger amount of oxygen, and venous blood a relatively larger amount of carbon dioxide than would be the case if this reciprocal relationship did not exist. Consequently, hemoglobin plays a very important role in the adjustment of individuals to high altitudes.

The amount of oxygen supplied to the cells of the body may depend on any one of, or a combination of, 4 conditions:

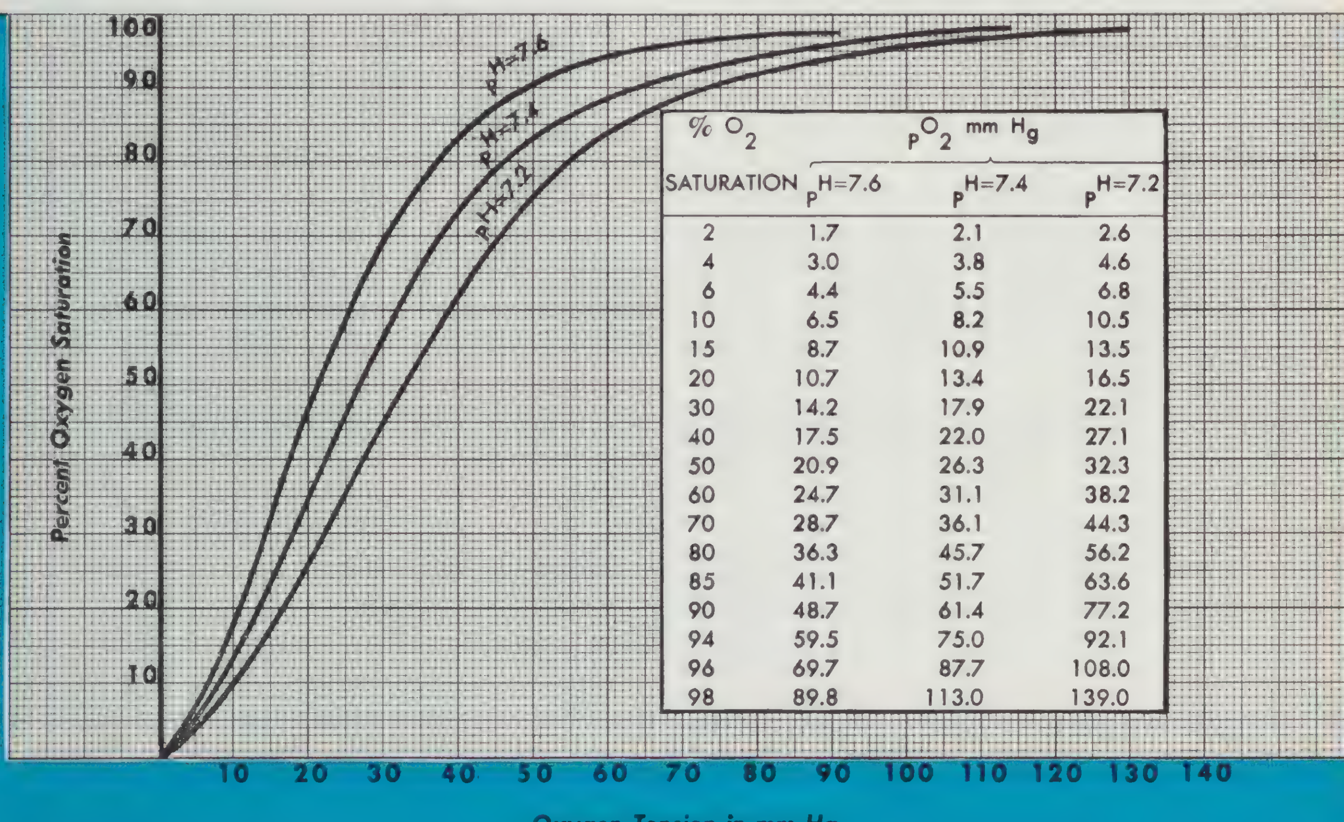
Classification of anoxia

The first and most common encountered is the result of a decreased partial pressure of oxygen in the air breathed. This is the *anoxic anoxia* encountered at high altitudes, either when the flyer neglects to use his oxygen equipment or when it fails.

A second, also encountered in flyers, is the inability of the blood to transport enough oxygen because of anemia resulting from excessive loss of blood, or because of carbon monoxide poisoning—the so-called *anemic anoxia.*

The quantity of oxygen delivered by the blood to the cells depends not only upon the oxygen-combining capacity of the blood but also upon the rate of flow of the blood. The latter is increased in a healthy person exposed to oxygen deficiency, but it may be decreased as a result of fear, pain, or injury, and cause *stagnant anoxia.*

The ability of tissue to utilize oxygen may be im-



% O_2	pO_2 mm Hg		
SATURATION	pH=7.6	pH=7.4	pH=7.2
2	1.7	2.1	2.6
4	3.0	3.8	4.6
6	4.4	5.5	6.8
10	6.5	8.2	10.5
15	8.7	10.9	13.5
20	10.7	13.4	16.5
30	14.2	17.9	22.1
40	17.5	22.0	27.1
50	20.9	26.3	32.3
60	24.7	31.1	38.2
70	28.7	36.1	44.3
80	36.3	45.7	56.2
85	41.1	51.7	63.6
90	48.7	61.4	77.2
94	59.5	75.0	92.1
96	69.7	87.7	108.0
98	89.8	113.0	139.0

OXYGEN DISSOCIATION CURVES FOR HUMAN BLOOD.

paired by poisons like alcohol and cyanide which interfere with cellular respiration and cause *histotoxic anoxia.*

The following discussion is concerned with the commonest form of anoxia encountered in aviation, namely acute anoxic anoxia.

Signs and symptoms

The signs and symptoms of acute anoxic anoxia depend on several variables:

1. Absolute altitude.
2. Rate of ascent.
3. Duration at altitude.
4. Ambient temperature.
5. Physical activity.
6. Individual factors.
   a. Inherent tolerance.
   b. Physical fitness.
   c. Emotionality.
   d. Acclimatization.

Clearly, the higher the altitude the more marked the symptoms. At rapid rates of ascent a higher altitude can be reached before serious symptoms appear. Length of exposure is an important variable. Whereas an altitude of 18,000 feet can be tolerated by most subjects for 30 minutes, symptoms are likely to appear at the end of that time. A high ambient temperature and physical exertion favor the development of symptoms at lower altitudes. Physical fitness and acclimatization from residence at high altitude raise an individual's "ceiling," while apprehension and lack of adequate physiological compensation by the respiratory and circulatory systems lower it.

For convenience's sake the symptomatology of anoxia may be divided into stages related to the approximate pressure altitudes and oxygen saturations of the blood as follows:

1. *Indifferent stage.* The only adverse effect is on dark adaptation which is manifest at altitudes as low as 5000 feet. It emphasizes the need for oxygen from the ground up at night, especially in the case of the pursuit pilot. Electrocardiographic changes occur at altitudes as low as 5000 feet but other circulatory manifestations are absent.

2. *Compensatory stage.* Physiological compensations usually provide an adequate defense against anoxia so that effects are latent unless the exposure is prolonged or unless exercise is undertaken. Respiration may increase in depth or slightly in rate. The pulse rate, the systolic blood pressure, the rate of circulation, and the cardiac output increase.

3. *Disturbance stage.* In this stage the physiological compensations do not suffice to provide adequate oxygen for the tissues, and latent oxygen-want becomes manifest. Subjective symptoms may include fatigue, lassitude, somnolence, dizziness, headache, breathlessness, and euphoria. Occasionally there are no subjective sensations up to the time of unconsciousness. Objective symptoms include:

a. Special senses.

Both peripheral and central vision are impaired and vision is dim. Extraocular muscles are weak and incoordinate, and the range of accommodation is decreased.

Touch and pain are diminished or lost.

Hearing is one of the last senses to be impaired or lost.

b. Mental processes.

Intellectual impairment is an early sign and makes

Stage	Altitude in feet: Breathing air	Altitude in feet: Breathing 100% oxygen	Arterial oxygen saturation percent
Indifferent	0-10,000	34,000 to 39,000	95 to 90
Compensatory	10,000-15,000	39,000 to 42,500	90 to 80
Disturbance	15,000-20,000	42,500 to 44,800	80 to 70
Critical	20,000-23,000	44,800 to 45,500	70 to 60

it impossible for the individual to comprehend his own disability. Thinking is slow, and calculations of a navigator or bombardier are unreliable. Memory is faulty for events particularly in the immediate past. Judgment is poor. Reaction time is delayed.

c. Personality traits.

There may be a release of basic personality traits and emotions as with alcoholic intoxication. There may be euphoria, elation, pugnaciousness, overconfidence or moroseness.

d. Psychomotor functions.

Muscular coordination is decreased, and delicate or fine muscular movements may be impossible. This results in stammering, illegible handwriting, and poor coordination in aerobatics and in formation flying.

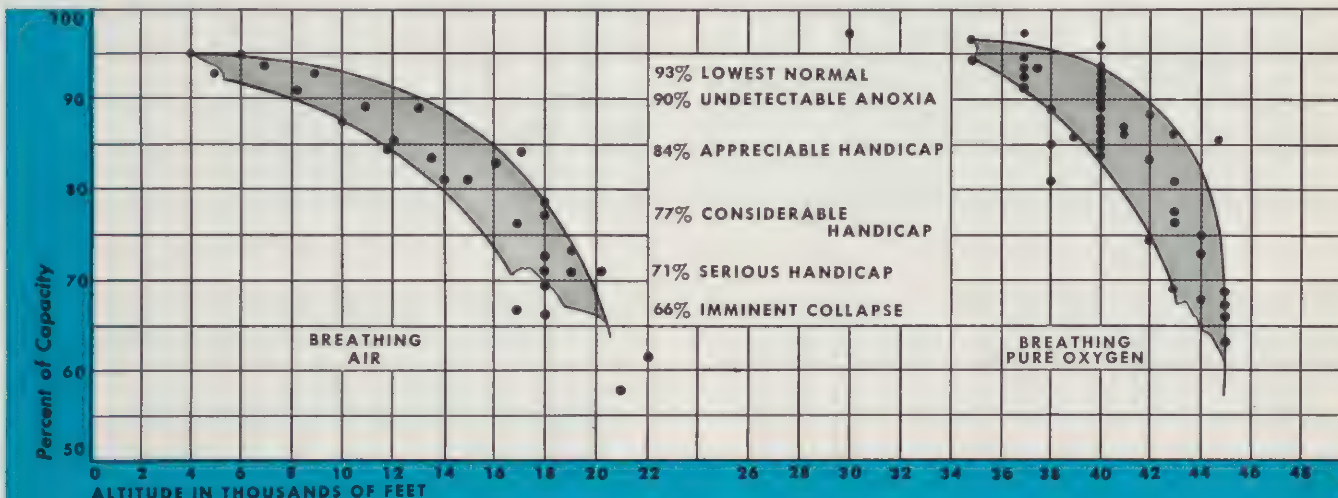
e. Hyperventilation syndrome.

f. Cyanosis.

4. *Critical stage.* This is the altitude at which consciousness is lost. This may be the result of circulatory failure ("fainter"), or of central nervous system failure ("non-fainter," unconsciousness with maintenance of blood pressure). The former is more common with prolonged anoxia; the latter with acute anoxia. With either type there may be convulsions, and eventual failure of the respiratory center.

Recovery

Recovery from anoxia is rapid when sufficient oxygen is supplied. An individual on the threshold of unconsciousness may regain his full faculties



Oxygen saturation (percent of capacity) of arterial blood and range of performance at various altitudes in subjects breathing air and in subjects breathing oxygen.

within 15 seconds when he receives an abundance of oxygen. Experience has shown that if an anoxic subject breathes deeply of oxygen, he may occasionally experience a flash of dizziness, but this passes immediately and is followed by complete restoration of normal function.

Sequelae

Headache and lethargy are common complaints after a prolonged period of severe anoxia. The headache appears to be general, but is particularly acute in the frontal region. The best cure is sleep, but the administration of 100% oxygen is advisable if the headache is severe. These symptoms have been explained on the basis of edema of the tissues, particularly the cerebral tissues, as a consequence of an increased permeability of the capillaries caused by the anoxia. Nausea, vomiting, and severe prostration may also occur but these usually clear up in 24 to 48 hours. Permanent cerebral damage resulting from anoxia has been comparatively rare, with only a few such authenticated cases on record.

Tolerance

Individual variation in the ability to withstand anoxia is considerable and accounts for variations in "ceiling." A large part of the tolerance is based on the adequacy of physiological adjustments, especially in breathing. The immediate result of deeper breathing is an increase of pressure of oxygen in the lungs and increased alkalinity of the blood. The latter favors uptake of oxygen by the hemoglobin. At such extreme altitudes as 40,000 feet, where 100% oxygen must be breathed, the barometric pressure equals the sum of the partial pressures exerted by water vapor, carbon dioxide, and oxygen. The pressure of the water vapor is relatively constant, tending to correspond to a saturated state of 37°C. Consequently, lowering of the partial pressure of carbon dioxide, such as occurs in deep breathing, will increase the partial pressure of oxygen in the lungs by an approximately equivalent amount.

Inexperienced personnel collapse more frequently at intermediate altitudes than do experienced individuals. The factors involved in such collapse are primarily psychogenic. The overventilation produced by anoxia ordinarily lowers alveolar carbon dioxide enough to produce only minor symptoms, such as dizziness, but does not have more serious effects. However, an individual who is apprehensive may hyperventilate to a greater extent and produce a degree of acapnia associated with more marked symptoms, such as tingling of the fingers and toes, blurring of vision, and carpopedal spasm. Such acapnia, added to the splanchnic vasodilatation which is a not infrequent response to fear, may bring about collapse.

Prophylaxis and treatment

If anoxia is encountered, the treatment consists of giving 100% oxygen by inhalation. If respiration has ceased artificial respiration along with the simultaneous use of 100% oxygen is indicated. If peripheral circulatory failure persists the type must be determined and treated accordingly.

The prevention of hyperventilation in flying personnel is largely a matter of indoctrination.

The principal treatment of anoxia is prevention. This is accomplished by the proper use of the oxygen equipment available in the AAF. The principal types are shown in the following figures. For further details, refer to appropriate T.O.'s of the 03-50 series, especially T.O. 03-50-1.

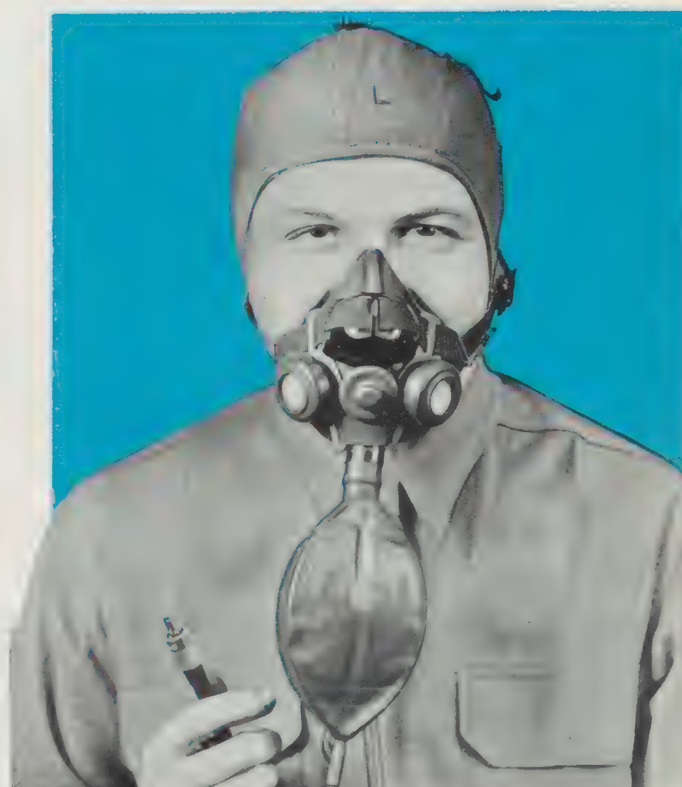
Pressure breathing

In order to prevent anoxia above 40,000 feet, some method of increasing the pressure of oxygen in the lungs must be used. One method is to "pressurize the lungs" by using an oxygen system which will de-

A-9A REGULATOR

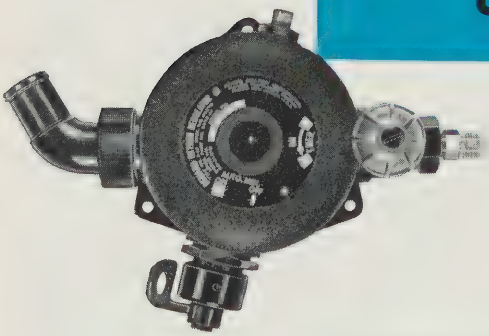
A-11 REGULATOR

A-7A MASK

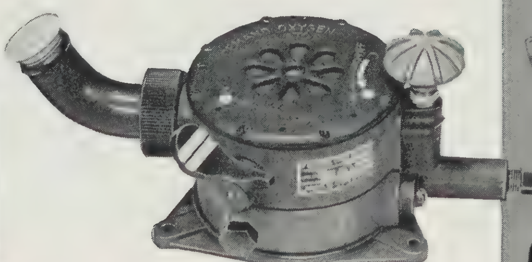


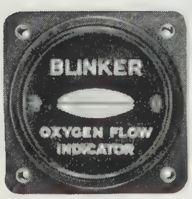
A-8B MASK

DEMAND OXYGEN EQUIPMENT

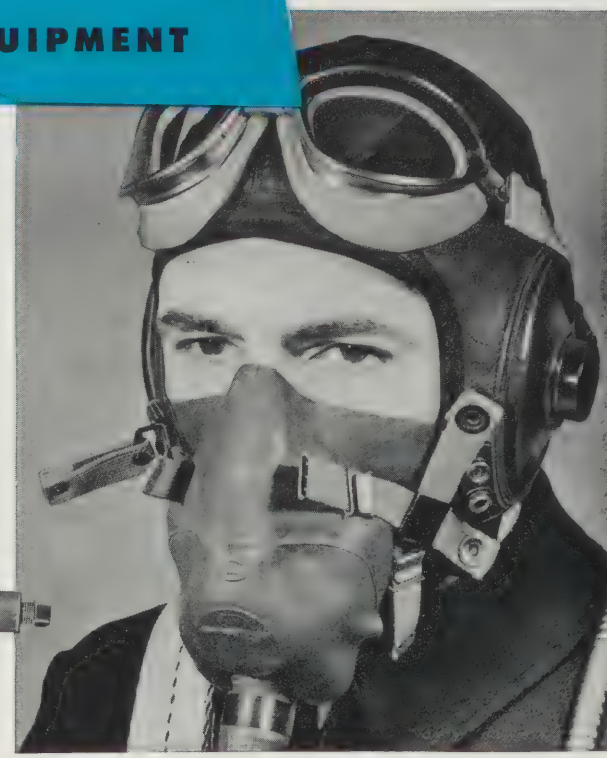


A-12 REGULATORS



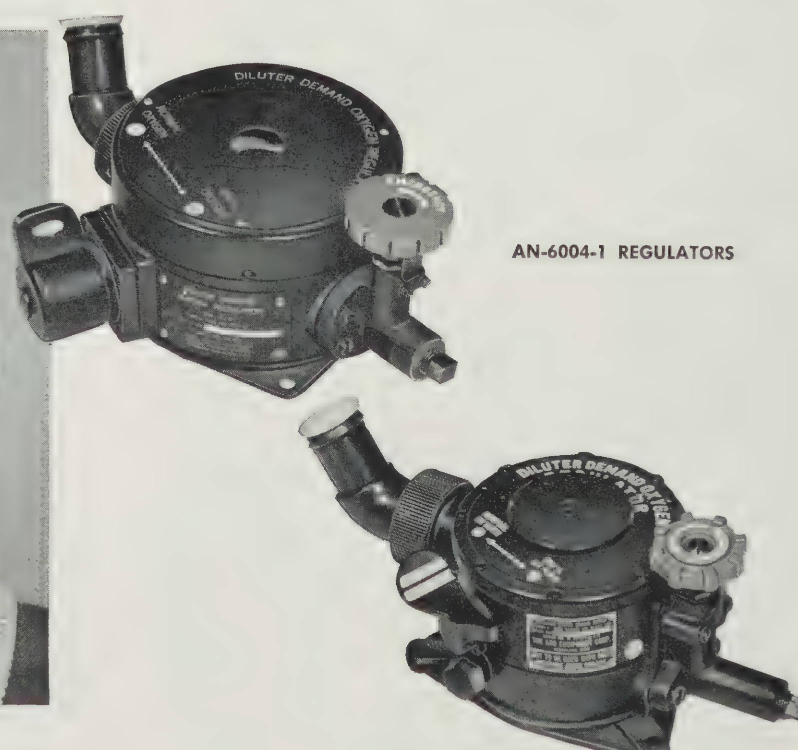


A-3 FLOW INDICATOR



A-10A MASK

A-14 MASK



AN-6004-1 REGULATORS

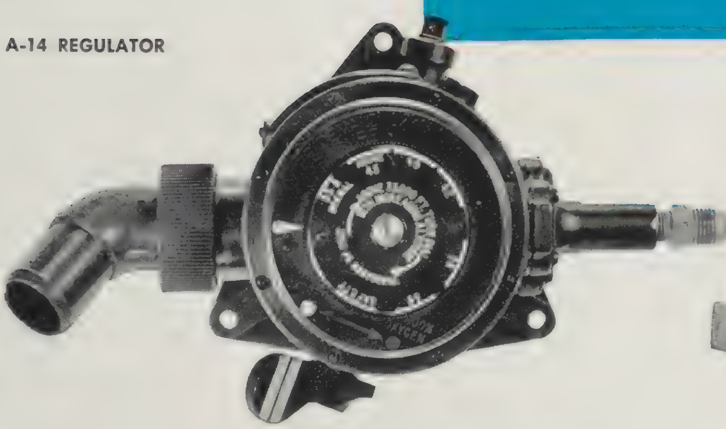
PRESSURE DEMAND OXYGEN EQUIPMENT

A-13A MASK

OXYGEN PRESSURE DELIVERED BY A-14 REGULATOR

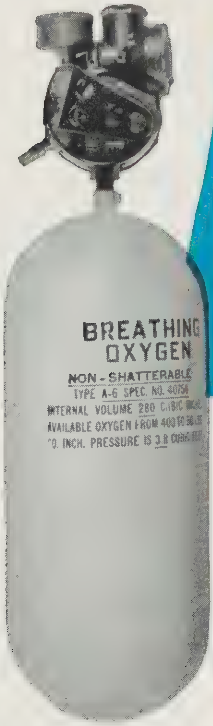
Dial Setting	Altitude Range in thousands of feet	Delivery Pressure mm. Hg.	Delivery Pressure in. H_2O
Normal	10—30	0	0
Safety	30—40	2	1
41	40—41	8	4
43	41—43	11	6
45	43—45	15	8
Above 45	45—48	23	12

A-14 REGULATOR



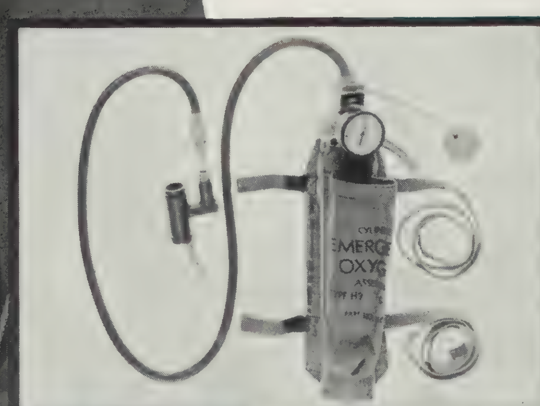
A-15 MASK

EMERGENCY OXYGEN EQUIPMENT



WALK AROUND BOTTLE
(A-6 Cylinder, A-15 Regulator)

WALK AROUND BOTTLE
(A-2 Cylinder,
A-8A Regulator)



H-2 EMERGENCY
ASSEMBLY WITH
MASK ADAPTER

liver oxygen at a pressure greater than ambient. Special regulator, regulator valves, mask and mask valves as noted above are required. The mask must remain sealed on the face even though positive pressure is applied.

Breathing pure oxygen under a pressure equivalent to 6 to 8 inches of water increases the tolerance to anoxia by approximately 2000 feet. Breathing against pressure entails a reversal in one of the essential characteristics of respiration. Expiration, normally a passive phenomena, becomes an active process. The average subject, however, adapts himself rather quickly and can breathe for several hours against 6 to 8 inches of water pressure at altitudes of 40,000 to 42,000 feet. With practice and training, danger from circulatory collapse is minimized. However, at these altitudes, decompression sickness is an ever present menace.

Above 8 inches of pressure, and especially at 12 inches, pressure breathing can be continued for only a limited period. In this range, some form of respiratory aid is desirable. At present, two methods are being studied: (1) The use of counter pressure applied to the outside of the chest by means of an inflated or elastic vest. (2) The use of intermittent pressure, which allows the oxygen pressure to be lowered during the exhalation phase but maintains a high pressure during the inhalation phase.

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EFFECTS OF DECREASED BAROMETRIC PRESSURE

Definition

Decompression sickness is a symptom complex which includes all the physiological effects of reduction in barometric pressure, independent of any effects of anoxia.

Classification

Decompression may be classified into two types, according to the environmental conditions which produce them. Symptoms resulting from decompression from barometric pressures in excess of one atmosphere, as in deep sea divers or caisson workers, are commonly called *compressed air illness* or *caisson disease.* Symptoms resulting from decompression from one atmosphere, as in aviation, are commonly called *aeroembolism* or *aeroemphysema.*

The symptoms may also be classified, according to their cause, into symptoms due to expansion of

trapped gases (abdominal gas pain, aerodontalgia) and symptoms due to evolved gases (bends, chokes, and neurological symptoms). On rare occasions pain may originate in the middle ear and sinuses as a result of gas trapped within these bony cavities during decompression, but in the majority of instances, aerotitis and aerosinusitis are compression phenomena (see Section 8-3).

Etiology

The *exciting factors* which produce decompression sickness are:

1. The expansion of gases in the gaseous phase within body cavities, and,

2. The formation of gas bubbles in body tissues and fluids from gas, principally nitrogen, which was previously in solution.

Gases within the body tend to expand on reduction of barometric pressure to a greater degree than Boyle's law demands. This exaggerated expansion is due to the fact that the gas remains saturated with water vapor at body temperature, and to the fact that the tensions of oxygen and carbon dioxide decrease at altitude less rapidly than the barometric

Normal subject at ground level. Gas around coecum and in splenic flexure and descending colon. Barium in stomach.

Same subject at 38,000 feet. Gas in colon greatly expanded; stomach (barium) compressed.

pressure. The most common manifestation of this gaseous expansion is abdominal pain.

At sea level the average adult body contains approximately one liter of nitrogen in dissolved form. As demanded by Henry's law, smaller proportions of this gas may be retained in solution as the barometric pressure is decreased. When the tissues and fluids become sufficiently supersaturated, the nitrogen is evolved from solution in the form of gaseous bubbles. These bubbles, depending upon their quantity and location, produce the major symptoms of decompression sickness. It is believed that the symptom of bends, which consists of pain in the extremities, is produced by such bubbles located interstitially in the connective tissue about bones, joints, and muscles. It is also believed that the symptom of "chokes," is caused by the accumulation of such bubbles intravascularly in the pulmonary circulation.

The *predisposing factors* to decompression sickness consist of two types, environmental factors, and factors influencing susceptibility of the individual. Among the former group it has been shown that the incidence of decompression sickness increases with:

1. Rate of ascent.
2. Altitude.
3. Duration of exposure to altitude.
4. Cold.

Individual susceptibility varies widely in individuals and within a given individual from time to tme. Age and obesity are the only two factors which have so far been identified as influencing individual susceptibility. Physical fitness and previous healed injuries to bones and joints within the limits encountered in personnel on flying status do not appear to influence susceptibility. However, susceptibility may be extraordinarily increased by exercise while at altitude. Exercise not only increases the incidence of symptoms at a given altitude, but lowers the threshold altitude for the occurrence of bends. Ordinarily, decompression sickness does not occur below 30,000 feet, but symptoms may be induced at altitudes as low as 22,000 feet by strenuous exercise.

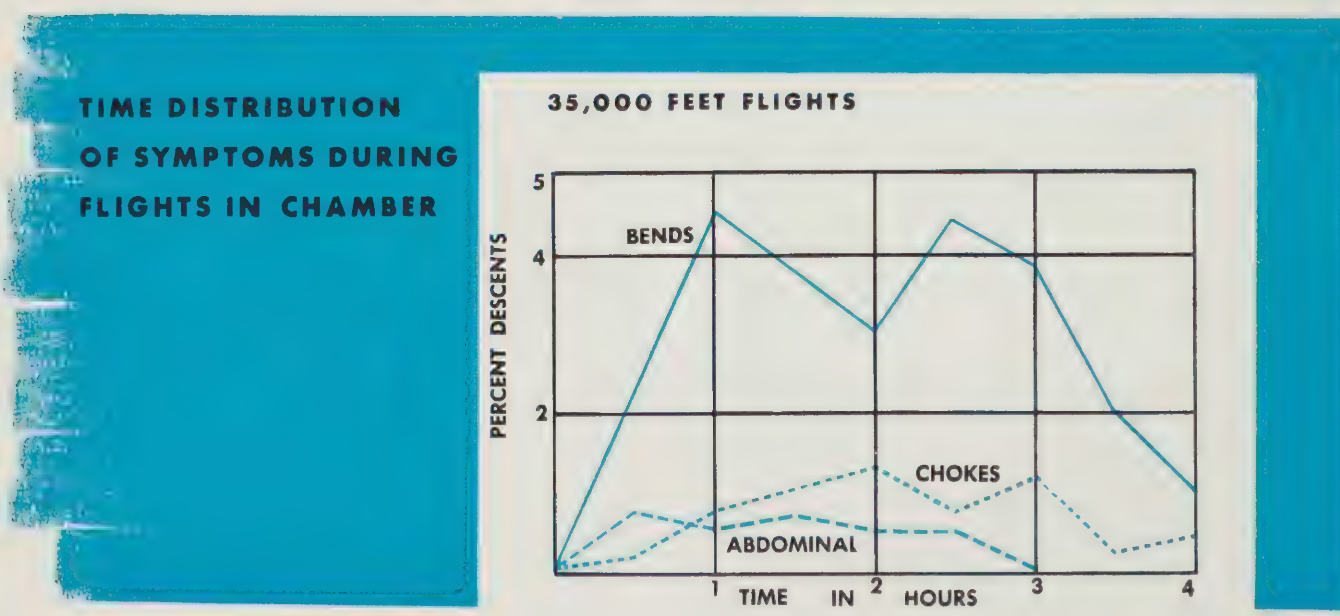
Symptoms

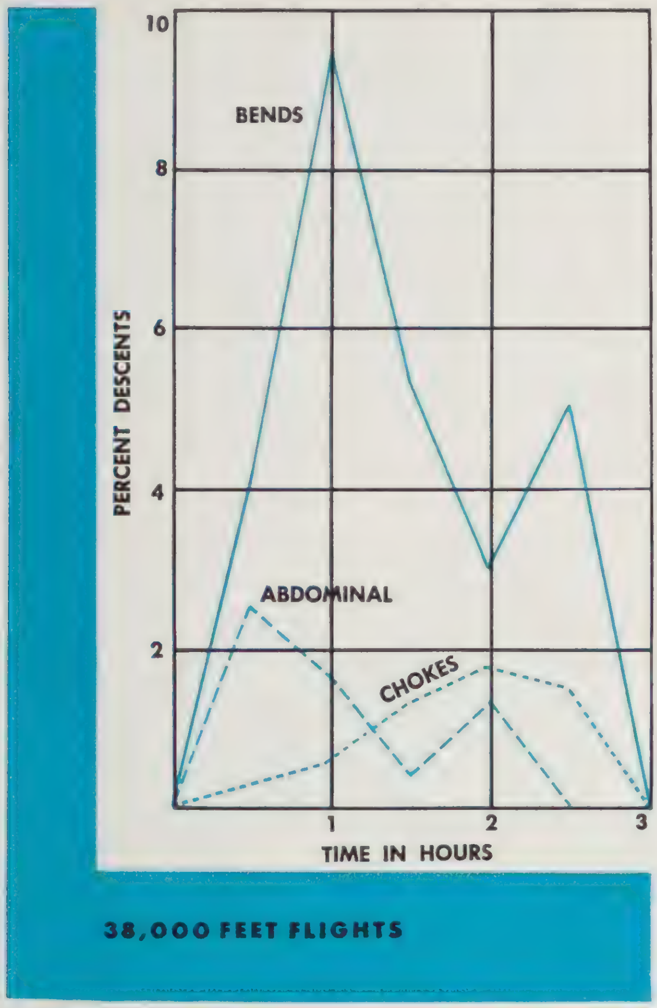
The most frequent symptom of decompression sickness is *bends,* which is characterized by pain in the extremities. The pain is of the deep type, frequently migratory, and not easily localized. The onset may be gradual or acute, and in either case may progress to the point of producing general circulatory reactions.

The next most frequent symptom of decompression is *chokes,* which is characterized by:

1. Substernal burning which is referred to the deep respiratory passages.
2. A non-productive cough arising from deep within the chest.
3. Aggravation of both the above manifestations by a deep breath, accompanied by a sense of suffocation and apprehension.

The chokes characteristically occur later in the course of a flight than the bends. The onset is almost inevitably progressive, leading to severe distress within a few minutes. General circulatory reactions are more common than in the case of bends.





Paresthesias of various kinds are commonly associated with decompression sickness, but are of little consequence. Similarly *skin rashes* sometimes occur, of which one form, an intense mottling due to interlaced pallor and cyanosis, is indicative of severe decompression sickness with complications. Occasionally, an area of *tenderness* and *swelling* may occur in subcutaneous or muscular tissue, which reaches its peak of activity some hours after flight and requires 24 to 48 hours to disappear.

Neurological symptoms of various types occur rather infrequently. The most common type is a transitory visual defect consisting of homonymous scotomata or even hemianopsia, followed by headache, which closely resembles migraine. More rarely transitory hemiplegia, monoplegia, aphasia, and disorientation occur. The neurological reactions differ from the other symptoms in their tendency to occur shortly after flight as well as during flight.

Abdominal pain is the most common symptom of expanding, trapped gas. In spite of its different etiology it occurs at about the same altitude as the other symptoms described above. It typically makes its appearance early in the course of the flight and may progress from a simple feeling of distention to severe, cramp-like pain. When severe, it readily leads to circulatory reactions.

Complications and sequelae

The most common complication of decompression sickness is a type of neurogenic peripheral circulatory failure or primary shock, consisting of one or all of the following manifestations: intense pallor, profuse sweating, faintness and dizziness, nausea, vomiting, and loss of consciousness. These circulatory reactions are usually initiated at altitude while the primary symptoms of bends, chokes, or gas pains are at their height, and recede rapidly as the primary symptoms are relieved by descent from altitude. However, in some instances the reaction persists after reaching ground level and may develop into the hematogenic form of peripheral circulatory failure or secondary shock.

Delayed circulatory reactions may also occur within several hours after return to ground level. After an apparent clear interval these delayed reactions may present the typical picture of secondary shock, with weak, thready pulse, hypotension, and intense hemoconcentration. A few fatal cases of this type have been encountered. In some instances neurological symptoms may usher in or accompany a delayed shock picture. Hemiplegia and coma have resulted, and in some instances permanent residuals and even death have followed such cases.

Treatment

The most effective prophylactic measure against decompression sickness is denitrogenation, i.e., the removal of dissolved nitrogen from the body before ascent to critical altitude, by breathing air containing a reduced pressure of nitrogen. The most rapid denitrogenation is accomplished by breathing pure oxygen, but breathing oxygen mixtures as delivered by the diluter mechanism of demand type regulators is also effective. Denitrogenation is just as effective in preventing decompression sickness when conducted in flight at altitude up to 20,000 feet as when conducted at ground level before flight. Above 20,000 feet, however, the effectiveness is gradually reduced. Breathing pure oxygen at ground level for 15 minutes will reduce the incidence of bends and chokes at 38,000 feet by approximately 50%; gas pains, how-

ever, do not respond to this prophylaxis. Decompression sickness is rare in current operational flying because of the limited altitudes of operation and because of the extensive denitrogenation permitted during prolonged ascent to altitude.

The prophylaxis of gas pains is a more difficult problem. The only reliable guide is to eliminate as far as possible any conditions or procedures which are actually known to cause abdominal distress at ground level, for ascent to altitude will aggravate the distress.

The *active treatment* of decompression sickness consists of recompression by descent to lower altitudes, preferably to ground level. All the primary symptoms of decompression sickness disappear completely or nearly completely during descent, usually before an altitude at 20,000 feet is reached. This is a useful diagnostic point. Recompression is the specific treatment for decompression sickness and there is no other effective treatment. Symptomatic treatment of pain with morphine at altitude is not very effective.

Treatment of the complications of decompression sickness consists of:

1. Complete rest for the duration of all symptoms.
2. The administration of plasma for overt or threatening hemoconcentration, and
3. The administration of oxygen for cyanosis or shock.

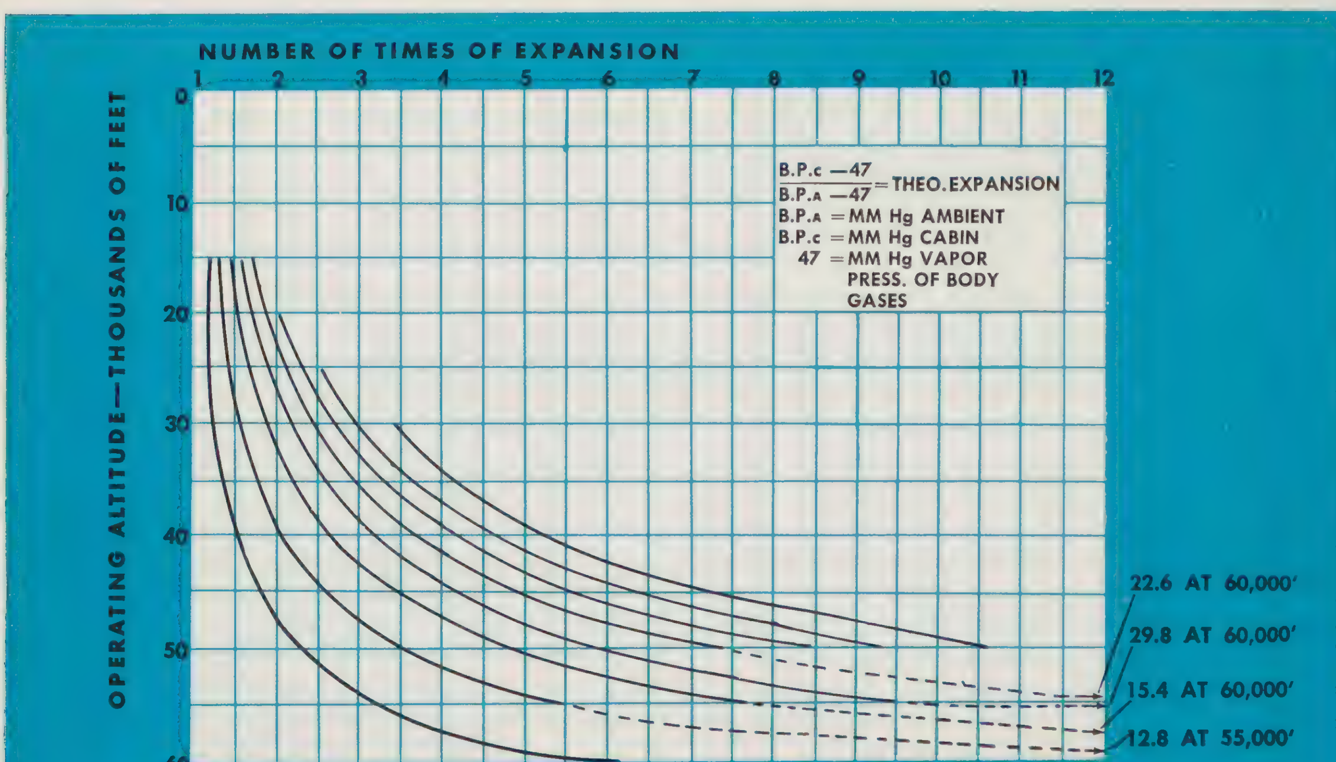
Close observation is important, for serious complications may follow apparently trifling primary symptoms after a clear interval of several hours.

Explosive decompression

The recent development of pressurized cabins in aircraft has raised the question of the tolerance of the human being to the extremely rapid decompression which may be expected if pressurization is suddenly lost as a result of enemy gunfire. The factors which determine the rate and extent of the decompression that may occur under such conditions are:

1. The volume of the pressurized compartment.
2. The size of the opening.
3. The pressure differential.
4. The flight altitude at which decompression takes place.

The first three regulate time or duration of decompression. With the time accurately measured and the pressure differential known, the rate of decompres-



THEORETICAL EXPANSION OF INTERNAL BODY GASES UPON EQUALIZATION OF CABIN DIFFERENTIALS FROM 1.0 THRU 8.0 P. S. I.

1. Symptoms of explosive decompression at 35,000 feet. Above, subject is sealed in a small chamber within altitude chamber at 8,000 ft. pressure.

2. Paper diaphragm on small chamber is punctured when outer chamber pressure is 35,000 ft. Subject experiences sense of inflation in chest and abdomen.

3. An instant later cheeks of subject are puffed by escaping air and he coughs and sneezes but remains conscious.

4. In full control of his senses, subject dons oxygen mask. Some pain may be felt in upper abdominal region. Less than a half second has elapsed between first and fourth photos.

sion can be determined in pounds per square inch (psi) per second. The last two factors listed regulate the extent of expansion of internal body gases, and from this figure and the time of decompression the expansion rate can be determined. The accompanying graph illustrates the theoretical expansion of internal body gases on equalization of cabin differentials from 1.0 through 8.0 pounds per square inch. The chart does not take into account the fact that the tension of oxygen and carbon dioxide decrease less rapidly at altitude than does the total barometric pressure.

The smaller the volume of the pressurized compartment or the larger the opening, the shorter is the time of decompression. When other factors are constant, an increase in pressure differential extends the time of decompression, but the decompression rate and expansion rate are also increased.

The physiologic effects of explosive decompression are produced by rapid expansion of gases within body cavities, and the degree of decompression which can be withstood safely is determined by either the extent or the rate of expansion. When expansion is slow, the body gases escape or become redistributed before dangerous pressures are built up. When the degree of expansion is slight, the lungs or hollow viscera can distend safely to make room for the expanded gases.

Expanding gas is expelled from the lungs with little resistance, but lung capacity can be only approximately doubled before physiologic stretching is exceeded. In decompressions with expansion of gases to several times their original volume at an extremely rapid rate, the response of the lungs is the limiting factor in tolerance of normal subjects to explosive decompression. The expansion of gases within the gastrointestinal tract causes distention and occasional twinges of pain. Persons with excessive abdominal gas may suffer more severe pain. No aural discomfort has been observed during rapid de-

compression, possibly because the eustachian tubes are blown open immediately and remain open during the change in pressure. If the subject remains at the high altitude following a decompression, aeroembolism may be expected to occur promptly.

Experimental work with human subjects has revealed that extraordinarily rapid rates of decompression can be tolerated with little difficulty. Explosive decompressions from 8,000 feet to 35,000 feet in less than 0.1 second created by an explosive hole greater than any as yet encountered in combat have been tolerated. The accompanying table lists the data from experiments on explosive decompression of human subjects.

Explosive decompression is associated with violent blasts of air through openings and through communication tunnels in bombers. This presents a serious hazard to personnel stationed near the opening or within the communication tunnel at the time of decompression. Examples of being swept out of the plane in the first case, or projected through the tunnel in the second are on record.

CONDENSED DATA OF EXPLOSIVE DECOMPRESSION EXPERIMENTS ON HUMAN BEINGS

Number of Experiments	Type of Pressure Chamber	Volume of Container (cu. ft.)	Size of Opening (in.)	PSI Differential Pressure	Simulated Altitude (ft.)		Time of Decompression (sec.)	Rate of Decompression (psi per sec.)	Expansion of Body Gases (no. of times)	Rate of Expansion (vol. per sec.)	Comparable Size of Hole in		Ascent in feet per sec.
					Cabin	Flight					1000 cu. ft. Cabin	45 cu. ft. Cabin	
Armstrong 26	1-Man Chamber	25	27	7.00	0	16,000	0.1	70	1.8	18			160,000
Dill 5	Chamber	. .	. .	11.9	0	40,000	165	.072	7.6	.046			242
J. J. Smith 5	1-Man Chamber	25	. .	7.25	10,000	40,000	1.6	4.6	5.0	3.0			20,000
Sweeney 10	Pressure Suit	3	4	2.75	27,500	45,000	0.015	125	3.2	213	80	18	1,166,666
150	P-38 Mock-up	45	12	6.55	10,200	35,000	0.075	87	3.5	47	66	12	330,666
15	P-38 Mock-up	45	12	7.5	8,000	35,000	0.09	83	3.9	43	66	12	300,000
9	P-38 Mock-up	45	27	1.5	34,000	45,000	0.008	143	2.3	288		27	1,375,000
3	P-38 Mock-up	45	27	1.25	37,000	48,000	0.006	167	2.3	383		27	1,833,333
2	P-38 Mock-up	45	27	1.00	40,000	50,000	0.005	200	2.3	460		27	2,000,000

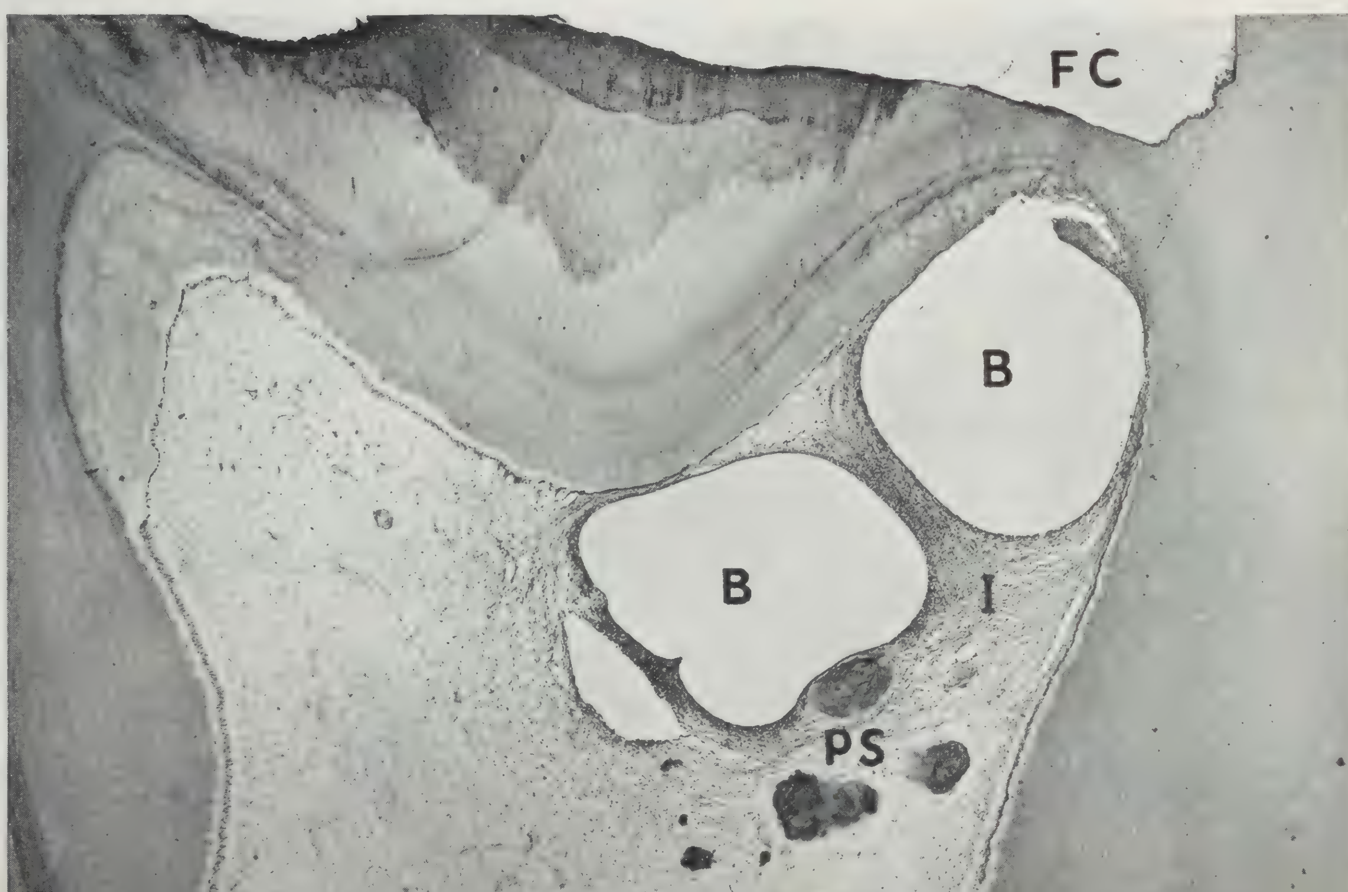
Aerodontalgia

Toothache experienced during or shortly after exposure to various degrees of lowered barometric pressure in actual flight or in a pressure chamber is called aerodontalgia.

Cause. It is probable that aerodontalgia does not occur with a healthy pulp. Toothache at altitude is most likely caused by an underlying lesion in the pulp which in time would cause the same symptoms without decompression. Predisposing factors in toothache at altitude are large, deep-seated, silver fillings without underlying base materials or insulators; and various stages of inflammation or degeneration of the pulp.

Microphotograph of normal pulp. No pain on ascent to 38,000 ft. PS—Pulp stone (after Orban).

Microphotograph of diseased pulp. Intolerable pain at 5,000 ft. B—"spaces" in pulp; I—inflammatory cells; PS—pulp stones; FC—floor of dental cavity. (After Orban.)



The exciting cause is usually reduction of barometric pressure. The pain is in general worse with greater and more rapid decompression; it is usually relieved by recompression. The precise "altitude of incidence," severity, and duration of pain will vary with the individual, and the type of lesion in the pulp.

Pain may first appear on descent from altitude or on recompression. This usually means that there is a non-vital pulp, or there may be maxillary sinusitis (see Section 8-3).

Pathologic anatomy. Available information indicates that pulpitis of varying degrees may be found together in some instances with "spaces" in the pulp. The nature of the pulpitis is yet to be determined.

Diagnosis. When several teeth are suspected of causing pain, those with recent amalgam fillings are more probably responsible. Testing with ice may produce the decisive diagnostic symptom. A tooth is to be suspected if it continues to hurt after removal of the ice. In doubtful cases reptition of the decompression is desirable.

A tooth with an open cavity will not be affected by altitude even though the pulp is diseased.

Prophylaxis. Aerodontalgia occurs only in potentially painful teeth. Careful scrutiny of the mouth with a complete x-ray of the teeth as part of the physical examination for flying will reduce the incidence of aerodontalgia by detecting dental abscesses, hidden cavities, defective fillings, large baseless fillings in close proximity to or in contact with the pulp, and periodontal diseases. Careful preparation of cavities is essential. Adequate oral hygiene is a most important prophylactic measure.

Treatment. A tooth with an exposed or diseased pulp should be extracted or treated if time permits. A cement of zinc oxide and eugenol is recommended only as an emergency procedure. If the cavity is deep, a cement or cavity varnish should be applied before the insertion of amalgam or silicate fillings.

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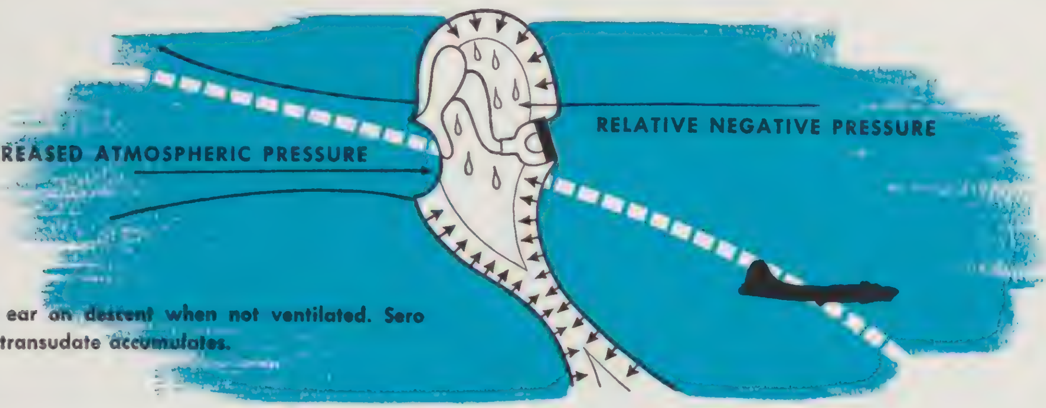
EFFECTS OF CHANGING BAROMETRIC PRESSURE



The middle ear on descent when not ventilated. Sero sanguinous transudate accumulates.

AERO-OTITIS MEDIA

Aero-otitis media is an acute, recurrent, or chronic traumatic inflammation of the middle ear, caused by a relative negative pressure of air in the middle ear compared to the pressure of the surrounding atmosphere. Although really a compression phenomenon, it is usually regarded as one of the manifestations of "decompression sickness" (see Section 8-2).

Etiology

The production of aero-otitis media is dependent upon two factors: (1) inadequate ventilation of the cavity of the middle ear, (2) a relatively marked and rapid increase of the ambient atmospheric pressure.

Normal ventilation of the middle ear is dependent upon the adequate function of the Eustachian tube. When not opened by swallowing or yawning, the pharyngeal end of the tube is similar to a flutter valve in that a sufficient increase of pressure (30 mm Hg.) within the middle ear will force the flaccid tubal walls apart and allow an egress of air into the nasopharynx. Conversely, a decrease of pressure in the middle ear will tend to approximate these tubal walls, and act as an antagonist to the musculature which normally opens the tube. A negative pressure of 80 mm to 100 mm of Hg in the middle ear is sufficient to prevent opening of an average normal Eustachian tube even during the act of swallowing. When there is relative or complete tubal obstruction, the differentials in atmospheric pressure created by descent from flight may be sufficient to cause pathologic changes in the mucosa of the middle ear. Such obstructions are usually due to: absence of voluntary middle ear ventilation (sleep or unconsciousness); swelling or thickening of the tubal mucous membrane; excessive secretions in the tube or over the ostium; and pressure of tissue on the tube or ostium (adenoids, polyps). The most frequent cause of acute, tubal inadequacy is upper respiratory infection.

Subjective symptoms

Symptoms are binaural in about 50% of cases. *Loss of hearing* is the most common and lasting sensation, and this loss may be similar to other forms of deafness due to flying. It usually becomes apparent while descending or immediately on landing, but may not develop until some time later. *Pain* is not experienced by all patients. The onset may be immediate or delayed; the severity may range from dull vague aching to sharp lancinating pain; and the duration may vary from a few minutes to several hours. *Tinnitus* of a humming or crackling character is commonly present, but it is ordinarily of short duration and is not regarded as a disability by most patients. *Vertigo* is rare.

Objective symptoms

One or several changes in the appearance of the drum may be observed: retraction, hyperemia and congestion of varying severity and extent, interstitial hemorrhages varying from petechiae to blebs, serosanguinous effusion into the middle ear, and rupture of the drum.

Differential diagnosis

Aero-otitis media may be easily differentiated from suppurative otitis media and external otitis by the appearance of the tympanic membrane. The history of onset and subjective symptomatology are helpful adjuncts.

AERO-OTITIS MEDIA	OTITIS MEDIA	EXTERNAL OTITIS
1. Due to change in barometric pressure.	Inflammatory	Inflammatory
2. Retraction of drum	Bulging of drum	Normal position of drum
3. Landmarks of drum accentuated	Landmarks of drum obliterated	———
4. Possible rupture of vessels	Diffuse erythema	Inconstant erythema
5. No thickening of drum	Thickening of drum	May be thickening of drum, if visible.
6. Usually no fever	Fever usually present	May be fever
7. White blood count normal	White blood count elevated	White blood count elevated
8. Serous or sero-sanguineous fluid in middle ear	Serous or seropurulent fluid in middle ear	No fluid in middle ear.
9. Variable subjective deafness	Profound subjective deafness	Hearing normal if canal not obstructed
10. Variable objective deafness	Consistent objective deafness	Hearing normal if canal not obstructed
11. No pain or pressure over tragus or on movement of auricle	No pain on pressure over tragus or on movement of auricle	Pain on pressure over tragus and on movement of auricle
12. No swelling of canal	Slight if any swelling of canal	Swelling of canal

Prophylaxis

Careful selection of aircrews and subsequent education with emphasis on the hazards of flying while suffering from rhinitis and nasopharyngitis will limit the incidence of aero-otitis media considerably. Each flyer should be encouraged to perfect by practice the simulated yawning technique for the equalization of pressures in the middle ear. The technique of clearing discharge from the nasopharynx, when present, by a forced inhalation of air and expectoration should be taught. A modified Valsalva maneuver or auto-inflation should also be taught each aircrew member.

The preflight use of vasoconstrictor solutions on the nasal mucous membrane and a slow rate of descent are palliative procedures, but do not always prevent the production of tubal blockage.

Treatment

In the acute case the neutralization of the negative pressure within the middle ear is most easily accomplished by continuous pressure Politzerization (see Section 7-3). Such inflations, repeated from 6 to 9 times, at 10-minute intervals, usually cause the serous discharge to disappear from the middle ear, and shorten the duration of the disease. In order to facilitate the inflation and forestall possible complications, vasoconstrictor solutions should first be repeatedly applied to the nasal mucous membrane and the nasal secretions should be removed by suction through a rubber catheter. The application of

vasoconstrictor solutions by atomizer, inhalator or by the dropper method in the head-low position are satisfactory.

Relief from severe pain has been accomplished in some instances by the Proetz displacement technique. Catherization of the Eustachian tube is experienced hands is undoubtedly successful, but if unskillfully used, may easily cause undesirable trauma.

The application of external heat to the ear is an empirically effective treatment and should be used in conjunction with sedatives and analgesic drugs in the few cases which do not obtain symptomatic relief following inflation.

Recurrences of aero-otitis media indicate a meticulous search for: chronic infections of the upper respiratory tract; tissue masses in the nasopharynx; evidence of allergy. Excessive lymphoid hyperplasia near the pharyngeal orifice of the Eustachian tube, as a cause of recurrent aero-otitis, may be benefited by nasopharyogeal irradiation.

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AEROSINUSITIS

Aerosinusitis is an acute or chronic inflammation of one or more of the nasal accessory sinuses resulting from a difference in pressure between the air or gas inside the sinus and the air of the surrounding atmosphere. Although the gradient is usually toward the sinus, the syndrome is nevertheless regarded as part of decompression sickness (see Section 8-2).

Dynamics

When a cavity (such as a sinus) with a small opening to the exterior is moved through environments of different barometric pressures, equilibrium between the gas inside the cavity and the gas outside will be established with a speed which will depend upon the size of the opening and the extent of change in pressure. When the sinus is normal and the ostium patent, free flow of gas between the cavity and the exterior brings about equilibrium during ascent and descent without sensation or change in structure.

During the flow of gas, 1 or 2 untoward events may occur: fluid, mucus, pus, or similar substances may enter the ostium with the gas as outside pressure is increased; or obstruction of the ostium by redundant tissue or an anatomical deformity may prevent equalization of pressures.

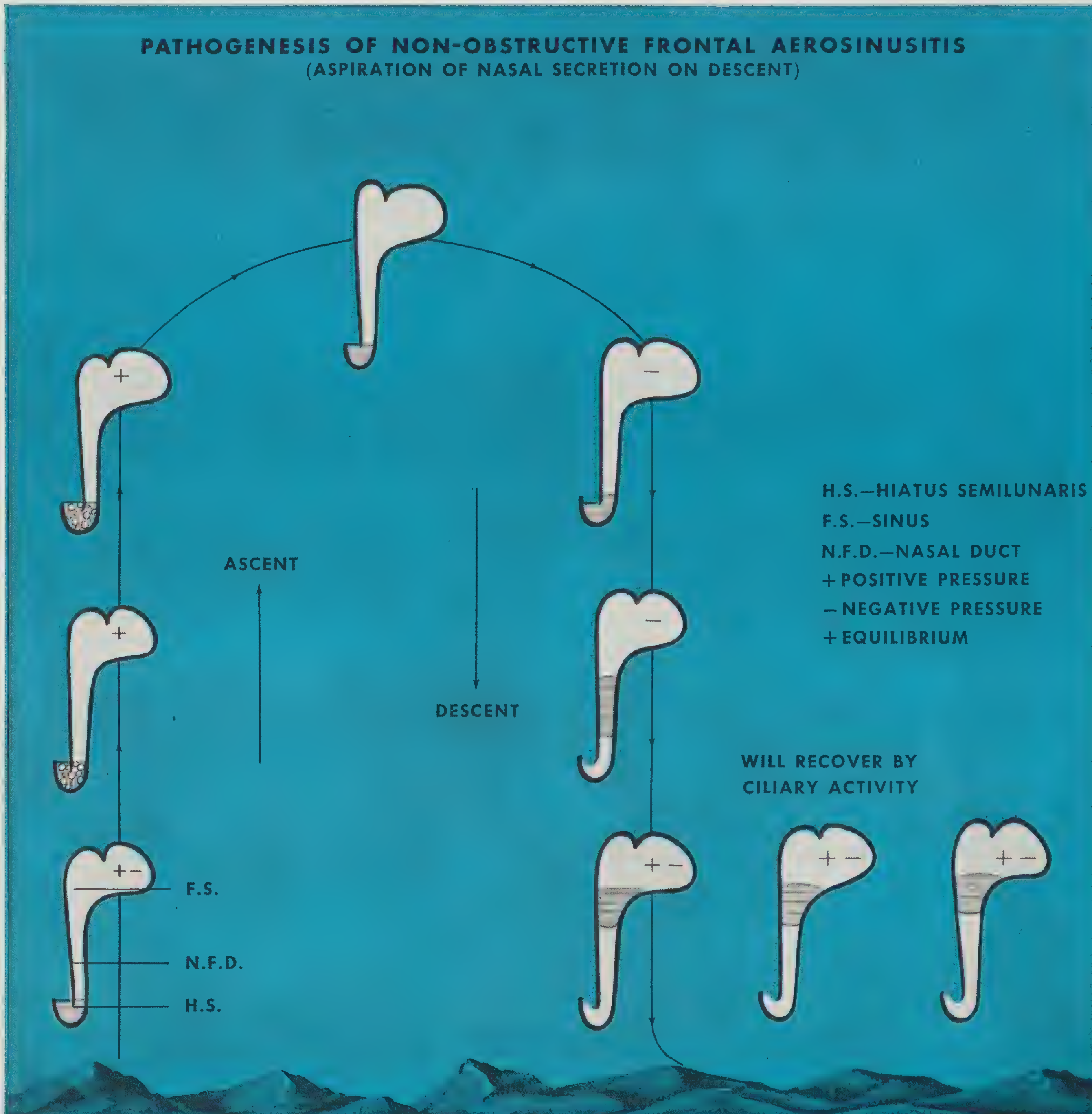
Classification

Non-obstructive aerosinusitis. When there is fluid, pus, or mucus covering the ostium in such a manner that it may be pushed away by a relatively small external fall in pressure, little happens on ascent as the flow of gas is out of the sinus. On descent, however, the direction of flow is reversed and fluid, mucus, or pus may be pressed into the sinus. Usually this phenomenon takes place without pain or other sensation. If the sinus becomes infected, the symptoms cannot be differentiated from the usual sinusitis except that there will be a history of lengthy descent in an aircraft during the existence of a productive cold.

Obstructive aerosinusitis. The circumstances are quite different when the ostium is blocked by swollen or redundant tissues, anatomical deformity or other means. In this instance the air or gaseous contents or the cavity are trapped and during altitudinal change produce a pressure, positive on ascent or negative on descent, relative to the environmental pressure.

The occlusive effect is believed to be due to a flutter-valve or ball-valve action. It is usually produced only during descent, when inflamed tissue such as a swollen turbinate or a polyp is pressed against or into an ostium in such a manner as to produce an airtight seal. Viscous secretions probably augment the seal.

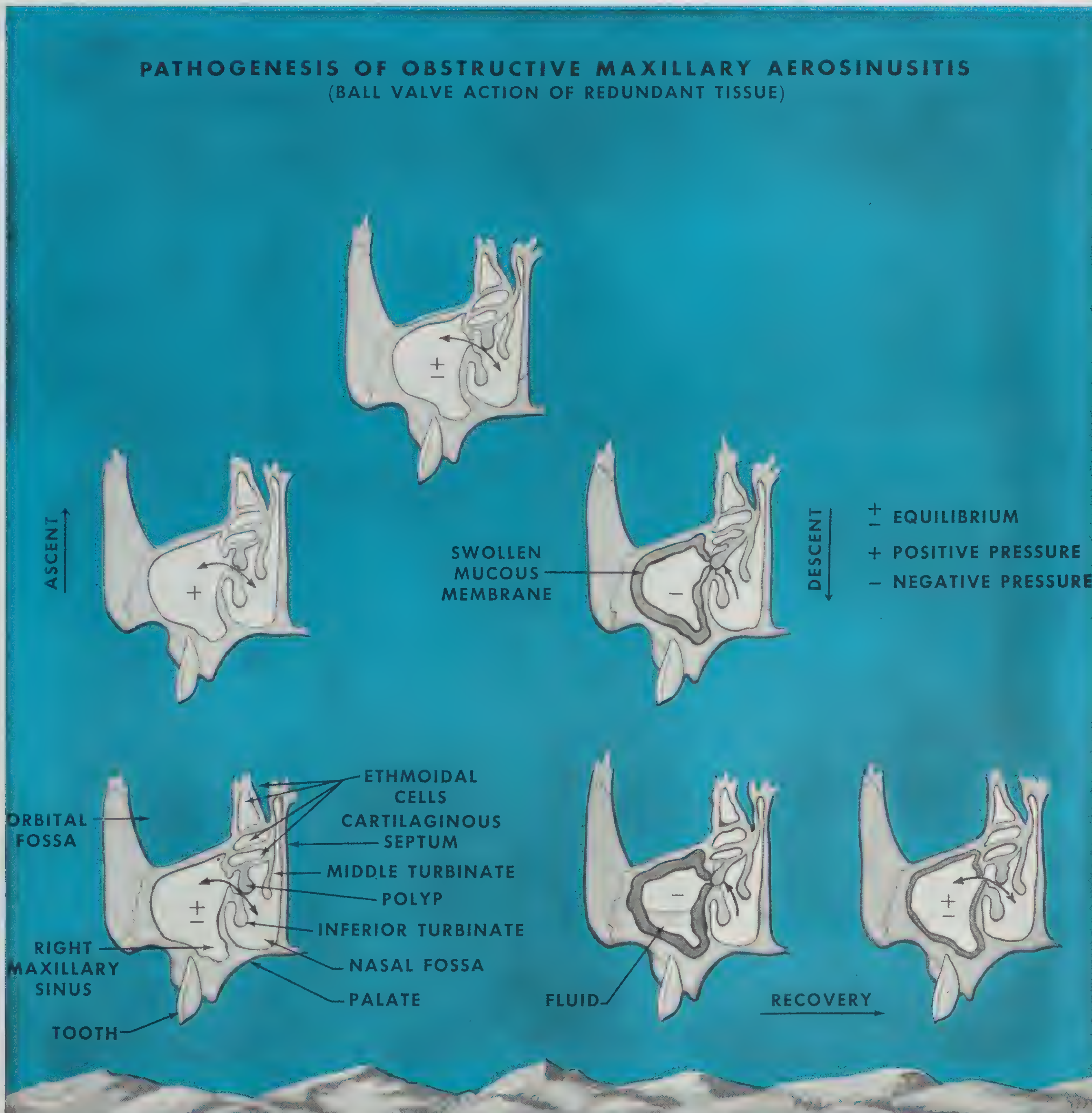
Natural attempts at equalization of the pressures on both sides of the obstructed ostium cause certain alterations of structure. The only elastic material which can appreciably alter the size of the cavity is the mucosa. An additional space-filling mechanism is production of fluid—mucus, blood, or serum.



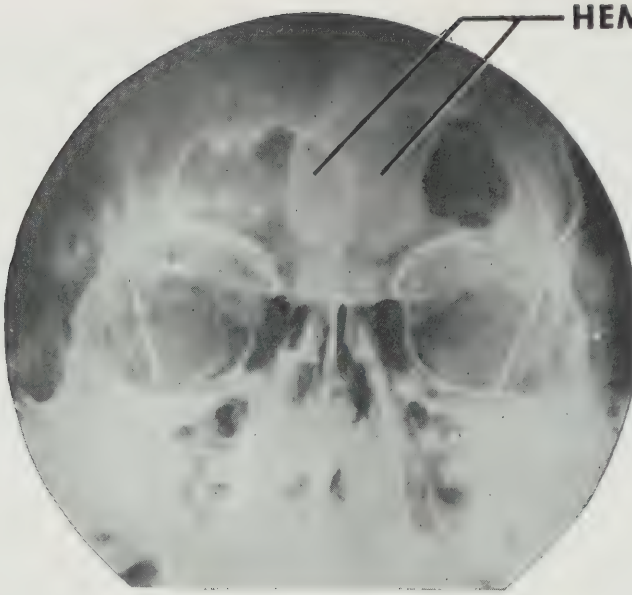
Symptoms

Rarely a patient reports pain over a sinus after a certain degree of ascent. Return to lower levels affords relief. Even remaining at altitude is usually not accompanied by much difficulty, for the gases under pressure are rapidly absorbed.

Blockage of a sinus during descent is by far more frequent. If the differential is small, adequate compensation for the relative negative pressure will be afforded by increased secretion of fluid. This condition may be labeled *first degree obstructive aerosinusitis,* and is characterized by only slight, if any, pain and usually insufficient symptoms to come to the attention of the physician. Second degree *obstructive aerosinusitis* is characterized by localized or gen-



eralized swelling of the mucosa with exudation of fluid accompanied by definite symptoms and signs. Pain and hyperesthesia over the sinus are present, and remain for some time (1 to 7 days) after descent. There is usually slight, if any, fever or leukocytosis. Roentgenography demonstrates thickening of the mucosa and possibly some clouding produced by fluid. *Third degree aerosinusitis* is a severe form. The differential pressure necessary to produce it must be relatively great—380 mm Hg or more. Excruciating pain over and about the affected sinus is present. Fever and leukocytosis are present. Roentgenography demonstrates thickened lining, clouding by fluid or blood, and at times, submucosal hematoma, or stripping of the mucosa. Resolution, if complete, takes from 7 to 21 days. It is probable that in at least some of these instances the injured tissues never return to normal.



FRONTAL AEROSINUSITIS WITH BILATERAL SUBMUCOSAL HEMATOMA

Sinuses involved

The frontal sinuses are involved most frequently. Aerosinusitis of the others is infrequent, or at least the complaints are so slight or so vague that they do not come to the attention of the physician.

Treatment

Non-obstructive aerosinusitis in most cases responds to the simplest forms of treatment. Shrinkage of the structures which might prevent normal drainage will usually allow normal ciliary activity to evacuate the materials which have been pressed into the sinus. The use of external heat is of value.

The obstructive types present a somewhat different problem. The primary therapeusis must be directed toward equalizing the pressures inside and outside the cavities. The ideal treatment is to return to the altitude at which the block occurred, correct the obstruction, and return slowly to ground level. This can be accomplished either in a low pressure chamber or by actual flight, and has given good results in some cases. However, the exact pathology should be known before such a procedure is instituted, for submucosal hematomas, stripping of the lining membranes and frank hemorrhage into the cavity of the sinuses will not be benefited and may be exaggerated by repetition of decompression.

Strictly conservative methods to aid space-filling production of fluid by the mucosa are in most cases sufficient. Heat over the sinuses not only aids fluid formation but also relieves pain. As soon as sufficient fluid has formed in the cavity of the sinus, pressure is equalized, the valve is released, and drainage and ventilation may take place, followed by normal healing processes. Mechanical movement of the tissues forming the block may often aid equalization of pressure.

The underlying pathology, if any, should be corrected after subsidence of the sinusitis.

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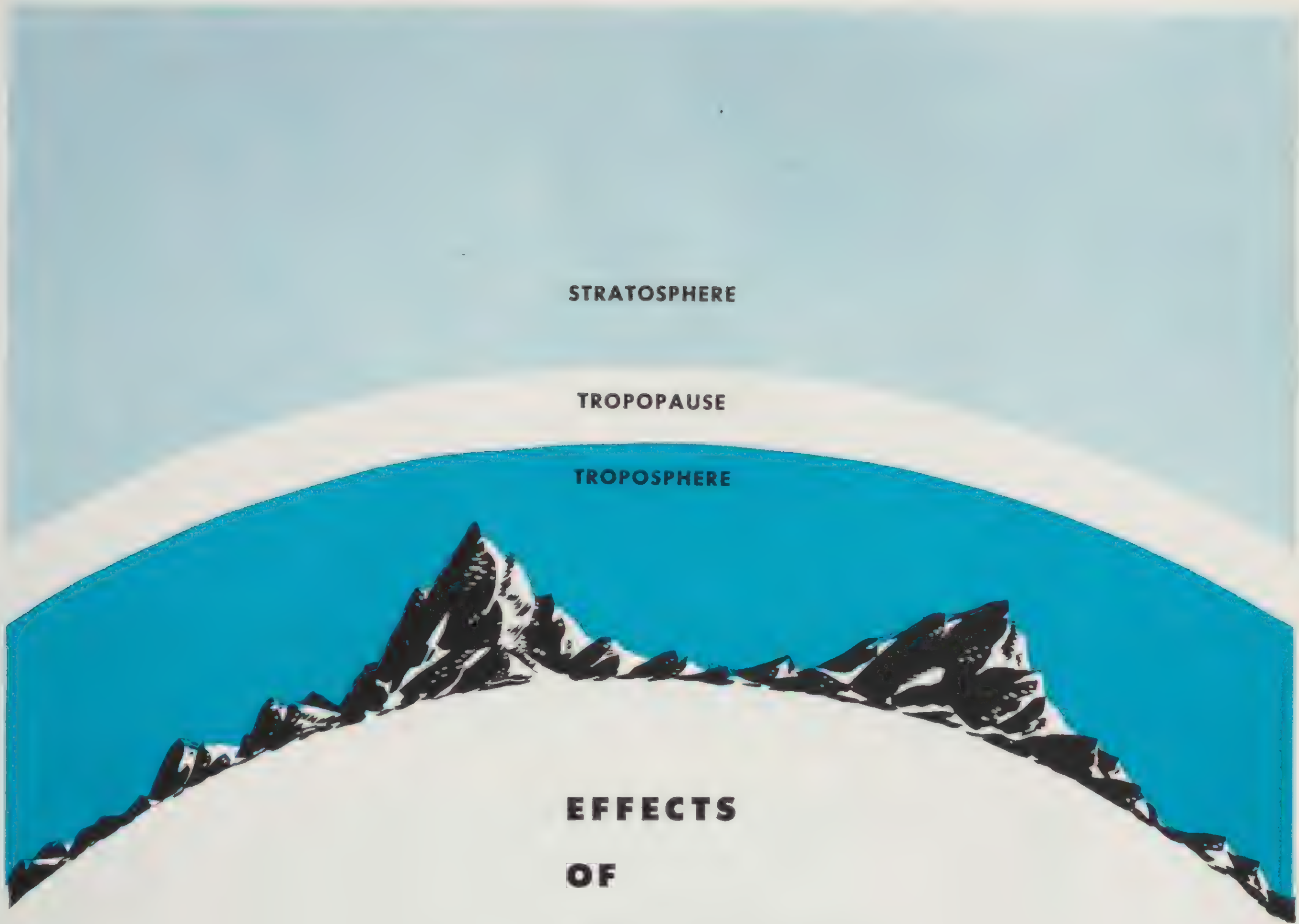


EFFECTS OF TEMPERATURE

Temperatures in the upper air

The atmosphere is divided into two concentric spheres:

1. The *troposphere,* which immediately surrounds the earth; and

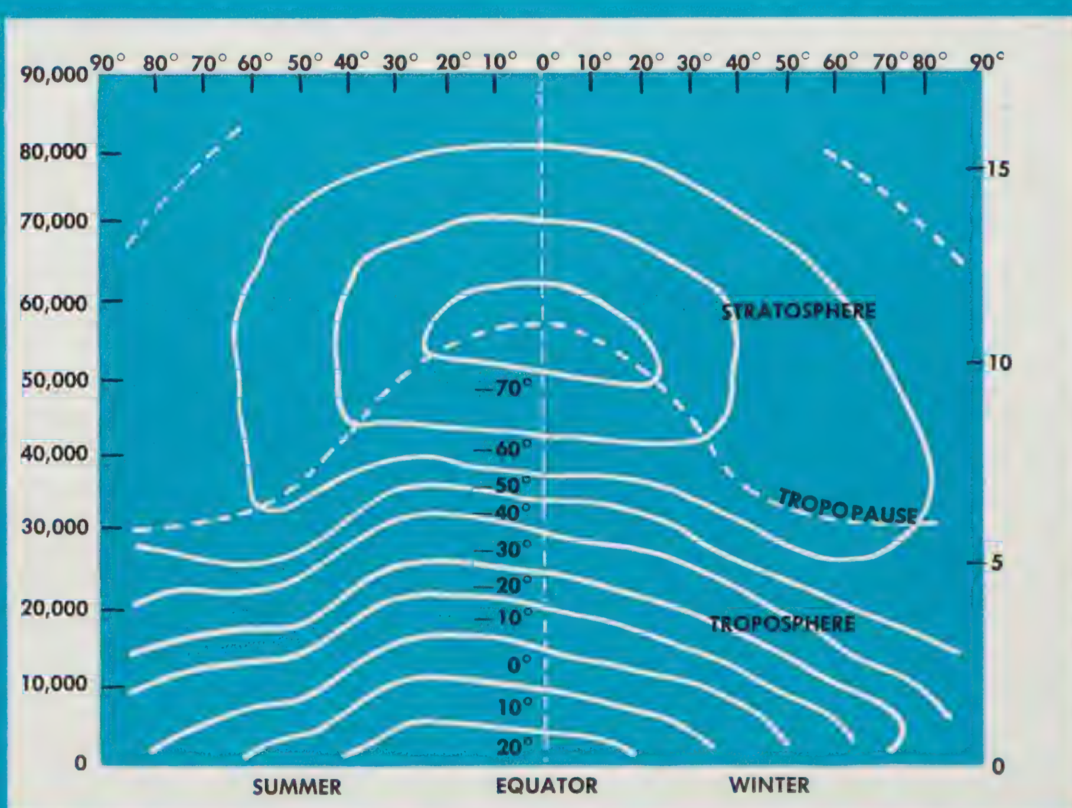
2. The *stratosphere,* which in turn surrounds the troposphere. The boundary between the troposphere and the stratosphere is called the *tropopause.* Its height varies with latitude. It is closest to the earth at the poles (approximately 6 miles) and farthest away at the equator (approximately 10 miles). The troposphere is characterized by a constant rate of decrease in air temperature as the height above the earth increases; by turbulent air; and by varying moisture content. All weather phenomena occur in the troposphere, for they are inherently associated with the physical properties of temperature gradient and moisture content. On the other hand, the *stratosphere* is characterized by a fairly uniform temperature which varies little with different altitudes; by the almost complete absence of turbulence in the air; and by the absence of moisture. The temperature of the stratosphere varies with latitude. The warmest stratospheric temperatures occur over the poles, where temperatures as warm as —40°C may exist. The coldest stratospheric temperatures occur over the equator, where temperatures as low as –80°C (—112°F) have been observed. Over the equator, at still greater heights, reversal of the temperature gradient has been observed.

The origin of all terrestrial heat is radiation from the sun. This radiation is absorbed at the earth's surface with the exception of that absorbed by clouds. All temperature phenomena in the atmosphere are caused by the presence of water vapor and by its absorption of "long-wave" radiation from the earth.

Near the earth's surface a body of air absorbs, by radiation from the earth, more heat than it can lose by re-radiation to other bodies of air and the heavens. When the temperature of a body of air increases, it tends to rise. As it rises, it expands because of decreasing atmospheric pressure. With expansion, the rising body of air cools, precipitating part of its moisture in the form of clouds. Hence its absorption of heat by radiation from the earth decreases. By repeated cycles of these physical phenomena, which are commonly known as "weather," relatively constant stratospheric temperatures of approximately —55°C are maintained. The water content of air in the stratosphere is so low that a balance exists between the absorption of radiation from the earth and reradiation to the heavens, thus causing a region of constant temperature regardless of altitude.

Regular changes in atmospheric temperatures from day to night are observed only to a height of approximately 3,000 feet above the ground. In general, temperatures of the upper atmosphere have no diurnal variation. Seasonal variations and variations caused by passing high and low pressure cyclonic areas change the temperature of the upper air.

Inversions of temperature have been observed near the earth's surface. For example, at the polar regions this inversion is very pronounced. At Ladd Field, Alaska, ground temperatures of —40°C to —45°C are not uncommon in the winter, while at the same time at 8,000 ft. temperatures as high as —5°C (23°F) may exist. It is a novel fact that extreme cold (that is, less than —40°C) usually is encountered either on the ground or in the stratosphere, but practically never at 10,000 feet, regardless of latitude.



Vertical section through the atmosphere, showing the distribution of mean temperature in degrees centigrade.

PHYSIOLOGIC CLIMATE STRESSES

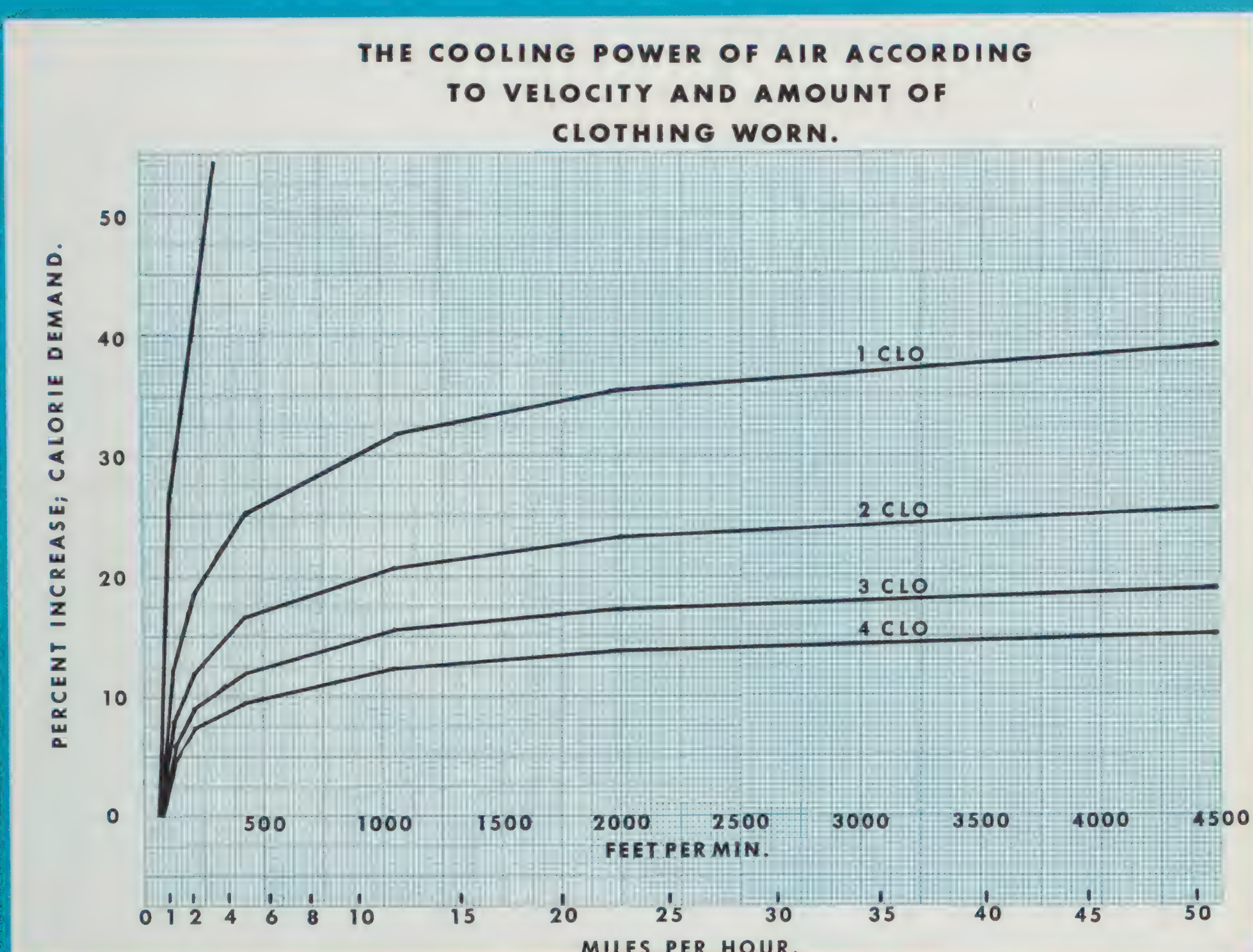
A working knowledge of the physiological and medical problems associated with environmental temperature may be divided into the following:

1. The interacting climatic stresses of temperature, air movement, humidity, and solar radiation which tend to cool or heat the human body.
2. The physical and physiological mechanisms concerned in regulation of body temperature.
3. The acclimatization processes.
4. The utilities of clothing, and other devices which aid in combating climatic stress.

Cooling stress—low temperature

In general, cooling stress is proportional to the total gradient between the skin and the environmental temperature. This determines the rate of heat loss from the body by radiation and convection. Except in very special circumstances, which are seldom of practical importance, low environmental temperature is properly represented by the air temperature. This obviously varies with season, climate, and weather, but its standard relationship to altitude, is of most interest to the flight surgeon (see Section 8-1).

Wind exerts a cooling effect upon an object warmer than its environment, as in the case of the human body exposed to cold. The magnitude of this cooling is represented in the figure which gives



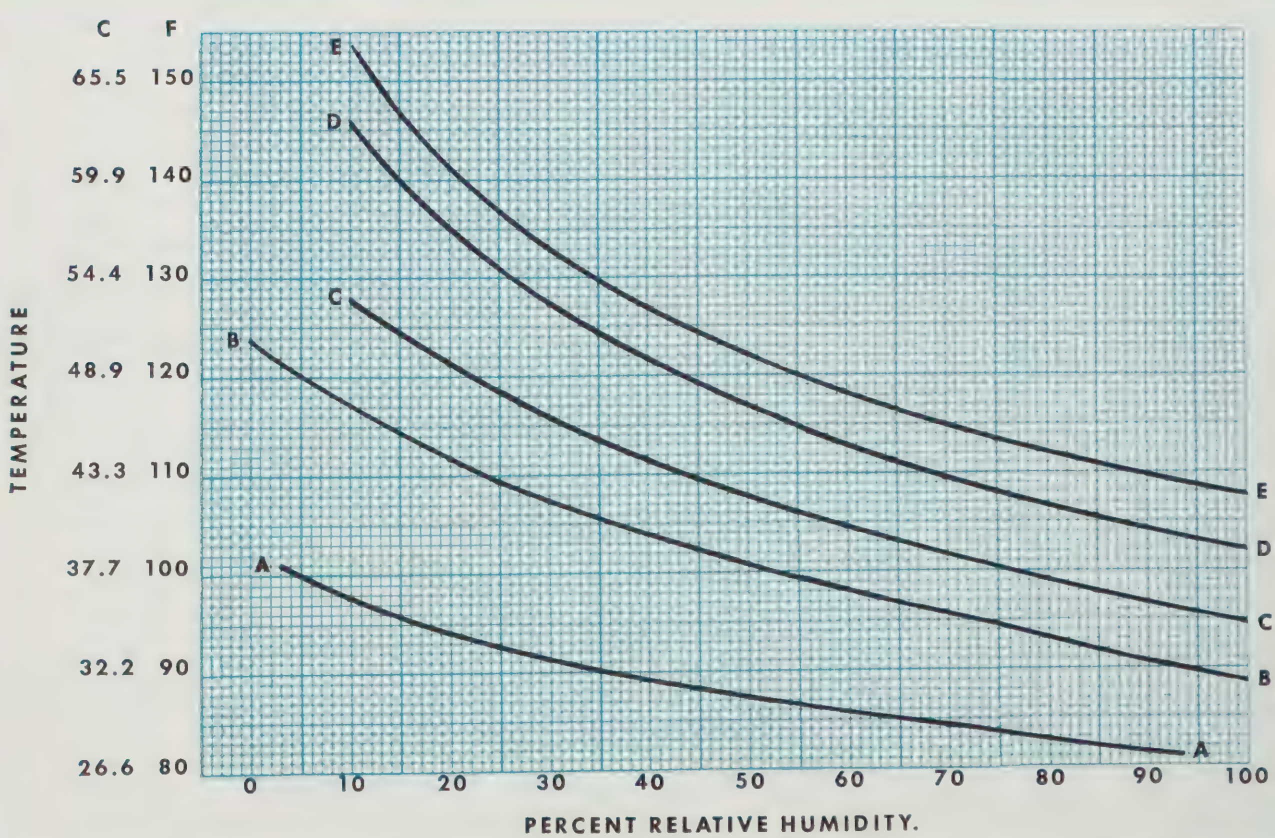
curves of relationship between the percentage increase in the calorie demand (the total gradient between the skin and air temperatures) and wind velocity for various amounts of clothing (expressed in clo, as defined below). With naked skin (zero clo) the effect of wind, since it acts in this instance to blow away the insulation afforded by layers of warm air at the skin surface, increases markedly with velocity. But with very heavy clothing (4 clo) the maximum cooling effect of wind is relatively small. Cooling stress is, therefore, proportional to the cooling gradient, and the added effect of wind is obtained by use of the appropriate curve in the figure, when wind velocity and the amount of clothing worn are known.

Heat load—high temperature

The heat load (heating stress) of the atmosphere is also proportional to the temperature gradient between the body surface and the environment, but the relationship here is the opposite of that which causes cooling, the body *gaining* heat by radiation and convection. There are 2 important additional factors:

1. The effect of humidity on evaporative loss.
2. The added heat gain from solar radiation.

The temperature-humidity effect can best be assessed in terms of physiological tolerance. The relations are shown in the figure which presents limits of tolerance for clothed, sitting subjects. It is noted



The limiting environments of temperature and humidity for human tolerance, employing criteria which range from easy to difficult: AA, the upper limits of summer comfort zone: BB, the limits of evaporative cooling, with little or no rise in body temperature; CC, the limits of compensated hyperthemia; DD, 60 minute tolerance, limit; and EE, 30 minute tolerance limit. (Winslow, Herrington and Gagge; Robinson, Turrell and Gerking)

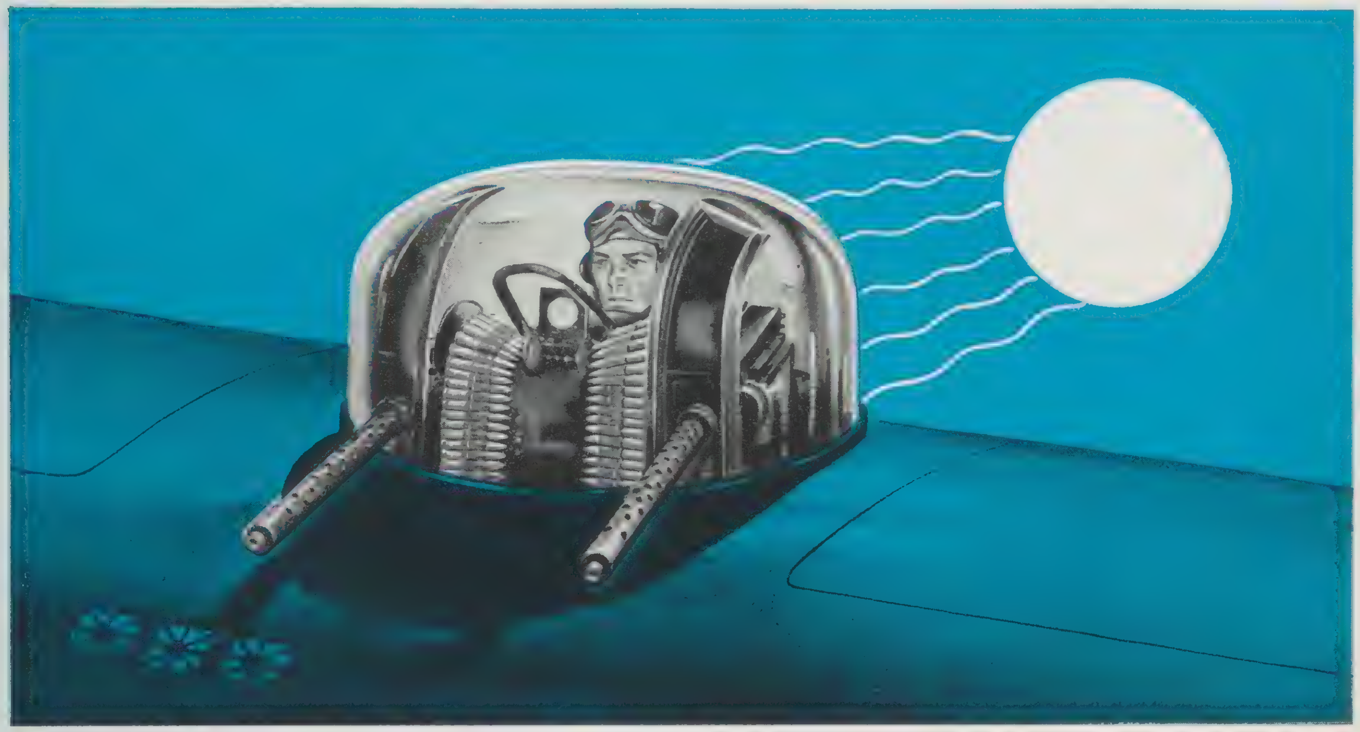
that in general a much higher temperature can be tolerated when the humidity is low (desert conditions) and that the tolerable temperature is lowered as high humidity is approached (jungle conditions). Line AA gives comfort limits; BB and CC show limits at two levels of physiological adjustment. Line BB gives the boundaries of evaporative cooling without hyperthermia, while line CC assumes more stringent conditions in which approximately 50% of the total adaptive capacity of the acclimatized individual is utilized in a 2-hour exposure. With shorter exposures, of course, more extreme temperature-humidity conditions may be tolerated, as shown by lines DD and EE.

Outdoor exposures in hot climates usually involve additional heat load from incident solar radiation, which has been calculated to be 240 kilo calories (k. cal.) per hour, or 2 to 3 times the resting metabolism. Such a heat load can be tolerated when the humidity is low; however, it is of practical interest to note that high humidities, solar radiations, and air temperatures do not occur simultaneously in any known climate on the earth. Generally speaking, all hot climates are tolerable for the suitably acclimatized man, except for occasional very temporary occurrences of intolerable extremes of these conditions.

AIRCRAFT CLIMATES

Under cooling conditions (winter and altitude), cabin temperatures depend on the efficiency of the heating system, the number and size of openings, and the type of plane. High altitude bombers, such as the B-24 and B-17, tend to have a temperature 5° to 15°C higher in the nose, radio compartment, waist, and tail than the outside air. Fighter planes such as the P-40, P-47, and P-51 are generally warm, although the P-38 is moderately cold at altitude. From present experience the B-29 is adequately warm at operating altitudes when cabin pressurization is used.

Extreme heat due to solar radiation is encountered in aircraft standing on the ground and in fighter craft at low and moderate altitudes (up to 10,000 feet). In "parked" aircraft, internal air temperatures may reach 15° to 20°C higher than outside temperature because the hot metal of the fuselage heats the impounded cabin air. Plexiglas canopies create a "greenhouse" effect in planes standing or flying under solar radiation. This effect is due to inward transmission of visible and near infrared radiation, thus heating the occupant and the walls of the cabin, which in turn re-radiate far infrared waves. But since plexiglas has a low transmission for long infrared there is radiant energy "trapped" with resulting increase in temperature.



REGULATION OF BODY TEMPERATURE

In common with other mammals, man possesses a delicate homeothermic mechanism which works in harmony with the physical processes of heat transfer to maintain body temperature at 37°C.

Physical processes

1. Conduction. Transfer of heat through solid, liquid, or gas from one molecule to another at a rate depending upon the specific thermal conductivity of the material and the temperature gradient between the two points under consideration is conduction. The heat exchange between man and his environment by conduction is ordinarily very small.

2. Convection. When liquid or gas comes into contact with a source of heat, it is heated, expands, and rises as it is displaced by the heavier, cooler liquid or gas which surrounds it. Such a process is known as "natural" or "gravity" convection. Prevailing winds or mechanical ventilation produce "forced" convection. Convection losses from the body are increased by low temperature, wind, and movement of the body.

3. Radiation. The human body receives heat by radiation from objects in the environment which are hotter than the body, notably the sun, and loses heat by radiation to the environment when the latter is cooler than the body. Radiation transfers are proportional to the size of the temperature gradient and body area exposed.

The sum of radiated and convected transfers either from body to the environment or vice versa is related to the total temperature gradient (Newton's law of cooling). For a practical grasp of most cooling and heat load problems, it is convenient to consider them together.

4. Evaporation. The body is enabled to lose heat by the process of vaporization of water from the surface and from the respiratory mucosa. Such transfer of heat derives from the fact that in the transformation of water into vapor without change in temperature, heat is taken up from surrounding materials. At usual skin temperatures, the value of 0.58 k. cal. per gram of water vaporized is commonly accepted.

5. Stored heat. Because of its large heat capacity, the body is further able to withstand cooling and heating stresses with a minimum shift in temperature. About 66 k. cal. of heat are transferred when the body cools or heats 1°C. Critical hypo- or hyperthermia results when change in storage reaches approximately 180 k. cal. in the average man, but at lesser transfers, storage may be considered as an adaptive mechanism.

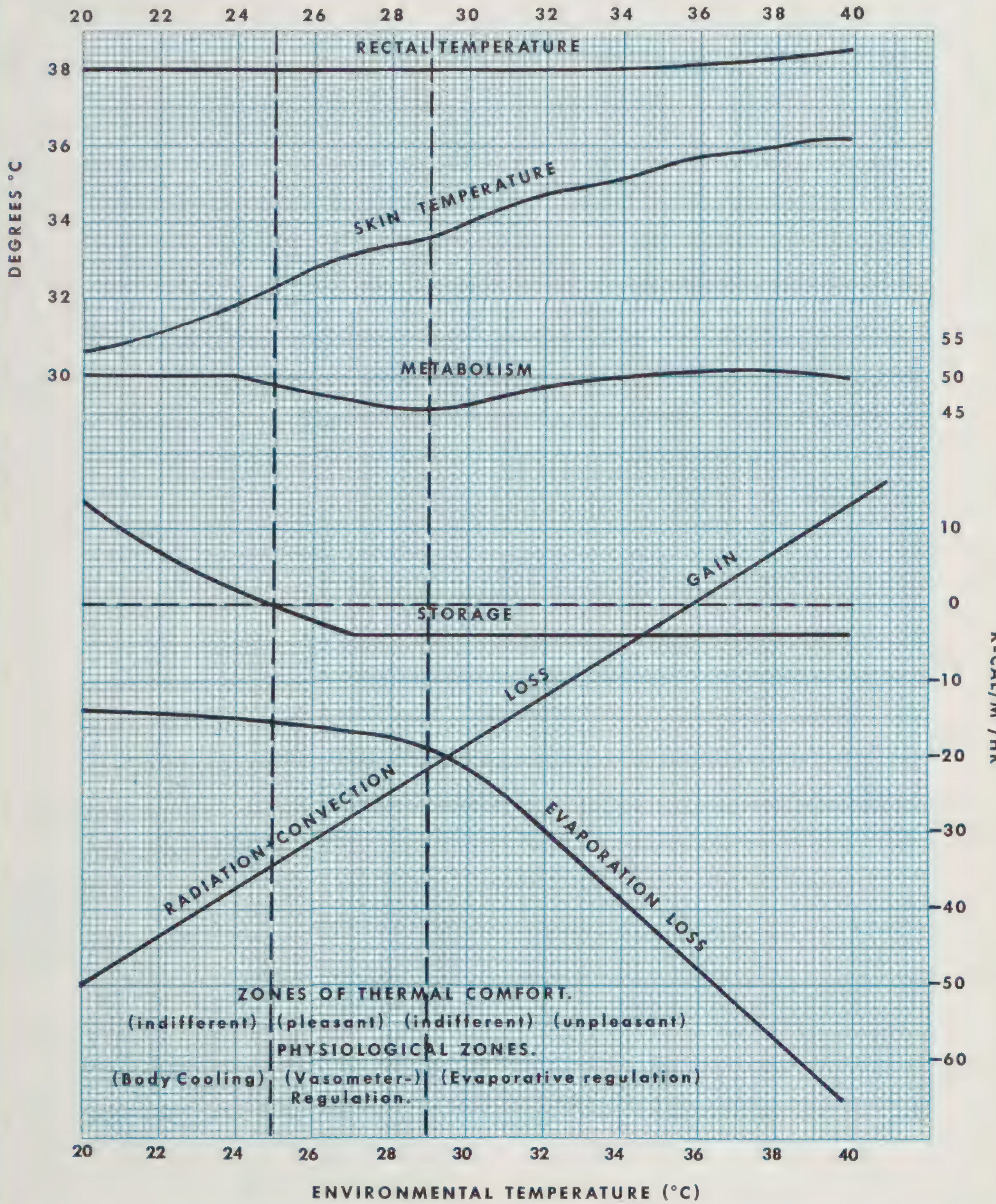
Physiological processes

1. Vascular. Alterations in peripheral circulation constitute one of the most important phases of regulation. Effective flushing of skin is accomplished not only by changes in tone of arterioles, venules, and capillaries, but also by the state of arteriolar-venular anastomoses (Sucquet-Hoyer canals) which are found particularly in the extremities. The primary importance of the sympathetic nervous system in this type of vasomotor activity is well established, although the afferent impulses which alter vasomotor tone may arise from many sources, including reflexes from the skin, particularly of the extremities, and from brain centers. Vasodilatation, on the other hand, is caused by a local thermal stimulus, although the possibility of a specific vasodilator reflex mechanism is not excluded.

2. Metabolic. Under normal environmental conditions, the basal metabolism is 40 to 50 k. cal. per square meter per hour, and the processes of physical regulation are adapted to dissipate this amount of heat. At low temperatures increased muscle tone (thermal tone), involuntary muscular activity (shivering), and voluntary muscular exertion all act to raise the heat production and thus to restore body temperature. In addition epinephrine, by virtue of its calorigenic effect, may be a significant factor in regulation of body temperature. A small increase in metabolism during hyperthermia has been consistently found in man and experimental animals; it is attributed to acceleration of many of the chemical processes of metabolism.

3. Respiratory. Similar to metabolism, the respiration is augmented at temperatures both above and below the neutral temperature zone. At high temperatures, breathing tends to be rapid and shallow, a type which favors respiratory evaporative loss usually without seriously disturbing the processes of gaseous exchange. At low temperature, ventilation increases, in part as a result of heightened metabolism and reflex effects of the cold.

4. Secretory. Though insensible water losses occur at all temperatures, thermal sweating begins at a skin temperature of 33°C and increases in proportion to heat load. Sweat losses may amount to 2 to 3 liters per hour in strong subjects working in the heat. Temperature of the blood is considered to be the most important stimulus, but sweating may begin before a rise in body temperature occurs.



The major physiological adjustments and modes of thermal exchange with the environment are correlated with environmental temperature. (Gagge, Winslow and Herrington.)

ZONES OF THERMAL REGULATION

Zone of Vasomotor Regulation (25° to 29°C). In this temperature range, characterized by sensations of thermal comfort, the processes of heat production and loss are so poised that variations in cutaneous vasoconstrictor tone are adequate to maintain thermal balance. Essentially the skin serves as a variable insulator. With cutaneous vasoconstriction, skin temperature is lowered and heat losses caused by convection and radiation diminish, but vasodilatation elevates skin temperature and increases these losses. Changes in stored heat and metabolism are small in this zone.

Zone of Body Cooling (24°C and lower). As the environmental temperature is reduced below the neutral range, and the cooling of wind is added, stored heat is lost, as shown by falling skin and rectal temperatures. Cutaneous vasoconstrictor activity is no longer adequate, and with cooling of the blood and skin surfaces, muscular hypertonus and shivering occur. At still lower temperatures these trends reach their extremes, resulting in a pale and constricted skin ("goose flesh") and heavy shivering, which may elevate metabolism to 3 times the basal rate. Though final breakdown of thermal control depends upon the degree of physical activity, amount of clothing and duration of exposure, 3 eventualities may occur:

1. If activity is restricted, the extremities, notably toes and fingers, approach freezing temperatures most rapidly, followed by depression of general body temperature. This type occurs most frequently in aircrew members.

2. If the individual is physically active, cooling develops with fatigue, and as exhaustion approaches, the vasoconstrictor mechanism is overpowered, sudden vasodilatation occurs with resultant rapid loss of heat, and critical cooling ensues. This is most frequent in Arctic or cold weather expeditions.

3. A third type is represented by "immersion foot," and "trench foot." Here, pathological effects are caused by long continued exposure to cold without freezing. The prolonged vasoconstriction interferes with the nutrition of the skin and results in accumulation of catabolites. Subsequent warming results in extreme reactive hyperemia with edema.

Zone of Evaporative Regulation (29°C and higher). The primary defense against hyperthermia is provided by evaporation of water from the surfaces of the skin and from the mucosa of the respiratory tract. Secretion of sweat is the active physiological process, accounting for most of the water available for evaporation. When environmental temperatures are higher than skin temperatures, and especially on exposure to intense solar radiation, the evaporative mechanism may be inadequate to balance the gain by radiation and convection, and hyperthermia, characterized by a rising body temperature and accelerated pulse, supervenes. A slight increase of metabolism is caused by the thermal stimulus, but most marked is the flushed skin resulting from maximal vasodilatation. The consequences of failure of heat adaptation may take different forms depending on type and duration of exposure and on the state of acclimatization of the individual:

1. "Heat stroke" results from inadequacy of the heat dissipating mechanism to meet the stress of high environmental temperature, usually combined with high humidity. The latter places a limit upon evaporative loss, and when the skin-to-ambient vapor pressure gradient is less than 10 mm of mercury, evaporative regulation is seriously impaired.

2. "Heat cramps" in the skeletal muscles are caused by excessive loss of sodium chloride in the sweat. This condition typically occurs in persons who undergo heavy exertion in the heat.

3. "Sunstroke" is generally attributed to hyperthermia localized in the brain or cervical cord, because of incidence of intense solar radiation on these areas.

THE ACCLIMATIZATION PROCESSES

Acclimatization to cold

Changes in thermal sensation are an outstanding accompaniment of long term exposure to cold. In the temperate zones all persons experience this type of adaptation to some degree during the winter season. Authorities disagree on the extent and duration of changes in metabolism with human acclimatization, but the metabolism of rats is increased by long exposure to cold if the adrenals are intact. Other studies emphasize the role of the thyroid gland in maintaining a higher metabolism under these conditions. Higher protein diets prevail in cold climates, and the specific dynamic action of this food element elevates metabolism. Whatever the nature of the psychological and physiological changes entailed and the extent of individual variation, acclimatization to cold is a matter of common observation.

Acclimatization to heat

The major changes occur within a week and are chiefly cardiovascular in nature. During this period the circulation adapts itself to the greatly increased cutaneous blood flow necessitated by the demands of heat dissipation. Heat stroke is prone to occur if exposure and activity are extreme, but its incidence is reduced as adaptation is achieved. With acclimatization, internal and skin temperatures, which increase abnormally in the heat, and pulse rates assume more normal values.

Later adaptations include increased loss of sweat, more dilute sweat, and, according to some authorities, increased plasma volume. Apathy, lack of desire to exert oneself, anorexia, and many other symptoms of maladaptation, which occur on initial exposure, become moderate or disappear entirely with acclim-

atization. In general, there are no qualitative differences between acclimatization to hot-dry and hot-humid conditions, and cross-acclimatization is effective. Gradations in exposure and activity in the heat are recommended to ease the transition from the unacclimatized to the acclimatized state.

FROSTBITE

When the environmental temperature of an exposed part gets below the freezing point of water, actual crystallization of the intracellular and intercellular fluids may occur with destruction of cellular structures.

Incidence in the AAF

From August 1942 to January 1944, 2008 crew members of the Eighth Air Force were frostbitten on combat missions. During the same time 1362 men received wounds from enemy gunfire. Ten and one-half days on the average were lost from flying duty by each thermal casualty, and 7% of the affected individuals were lost permanently. The average loss from frostbite for the entire period was 0.58% of all individuals dispatched on heavy bomber missions.

After July 1943 improvement in design, supply and care of the electrically heated flying equipment resulted in a decline in the frequency with which hands and feet were affected by the cold. During the same period, frostbite of the face, neck and ears rose proportionately.

From January 1944 the rate of frostbite per thousand man missions steadily declined from 0.50% to

AFFECTED AREA	TOTAL PERIOD	BEFORE JULY 1943	AFTER JULY 1943
Face, neck and ears	45%	17%	53%
Hands and feet	54%	82%	46%

The combat position in the plane proved to be of major importance in establishing the likelihood and location of exposure.

POSITION	TOTAL % OF FROSTBITE	NUMBER OF OCCUPANTS	VULNERABILITY RATIO
Waist gunner	50%	2	25
Tail gunner	14%	1	14
Ball turret gunner and radio operators	20%	2	10
Cabin and nose	8%	5	1½

POSITION	FACE, NECK & EARS	HANDS	FEET
Waist gunner and radio operator	59%	27%	14%
Tail gunner	38%	38%	24%
Ball turret gunner	17%	34%	45%
Cabin and nose	16%	40%	44%

Waist gunners and, to a smaller extent, radio operators are particularly exposed to windblasts; this fact accounting for their high incidence of frostbite of the face, neck, and ears. The percentage of frostbite casualties from various causes were as follows:

CAUSE	% OF TOTAL	% BEFORE JULY, 1943	% AFTER JULY, 1943
Windblast	39	9	46
Failure of equipment	24	26	24
Lack of equipment	12	10	13
Removal of equipment	9	13	8
Other or unknown	15	42	9

reach a low of 0.03% by August. Many factors were contributory, but most important were reduction in wind blast, particularly in the waist gunner's position in the B-24 and B-17; careful indoctrination of flying personnel by the flight surgeons; and particular care, supervision and improvements in electrically heated equipment by the personal equipment officers.

Etiology

Factors to be considered in the production of frostbite are the cold stress, duration of exposure, wind

velocity, contact with metal, moisture of the clothing, and external constriction of the limbs by clothing or position. Factors within the flyer himself that are important in determining his resistance to a given amount of cold are impairment in the circulation to an exposed part either from previous frostbite, circulatory disease, including vascular wounds or smoking, and general debility. The wounded, anoxic, or anemic individual is more susceptible to the deleterious effects of cold.

Freezing of skin usually does not occur until the environmental temperature is below —10°C. At temperatures of —30° to —50°C, 1½ to 2 minutes are all that are needed to produce a solidification of the fingers. Periods of time beyond these may result in irreparable damage. Moisture lowers the critical level by conduction and evaporation, and increases the speed at which freezing occurs. Sweat on gloved hands increases their likelihood of freezing on exposure. Freezing of thighs and buttocks may occur when moistened by urine.

Removal of gloves was the cause of many severely frostbitten airmen in the early days of combat over Germany. Contact with metal surfaces at low temperatures resulted in instantaneous freezing of the skin to a gun, for example, with removal accomplished only by tearing of the skin.

The extremely bulky clothing used during the early period of the war tended to constrict the circulation of the extremities. This was particularly so at the points of flexure where the leather jackets became so stiff from cold as to be unbendable. These same clothes furnished inadequate protection for the duration and degree of cold encountered so that chilling with peripheral vasoconstriction was frequently combined with external constriction of the circulation of the extremities to produce local ischemia.

Physiology and pathology

The changes which occur with frostbite, typically in the skin, may be divided into stages as follows:

1. Ischemia.
2. Freezing.
3. Hyperemia.
4. Necrosis.
5. Healing.

Ischemia is the result of direct and reflex vasoconstriction and represents a sacrifice of local circulation to the skin for the sake of maintaining general body temperature. Freezing consists of actual solidification or crystrallization of the intracellular and intercellular fluids. Hyperemia occurs when circulation is reestablished to a tissue which has been ischemic and anoxic for a variable period of time. This is accompanied by edema because of the impaired permeability of the capillaries, and there may be extravasation of blood into the tissues if the capillary endothelium has been destroyed by freezing. Occlusions are found in sectioned tissues at the arteriolar-capillary junctions which are believed to be thromboses. These are found particularly in tissues which have shown dry gangrene following frostbite, and the dryness of this lesion is attributed to the inability of blood to get into the capillary bed in such cases. Necrosis of variable degree occurs in those tissues which have been frozen and probably also in those which have been anoxic simply on the basis of prolonged vasoconstriction.

Later changes consist of regeneration of skin and capillaries and a variable degree of fibrosis and round cell infiltration in the skin. Bones which are involved show osteoporosis. Arterioles display intimal proliferation.

Symptoms

The symptoms may be divided into early and late. The frozen extremity is white, hard, friable, waxy, and anesthetic in that it is bloodless and solid. After thawing has occurred vasoconstriction may persist for a matter of hours. When circulation is restored the part becomes hyperemic. There may be edema and vesication of variable degree. The skin becomes dull and dark, and if there is extravasation of blood into blebs there may be considerable discoloration. As demarcation develops in a matter of days those parts which have lost viability will undergo desquamation or mummification and spontaneous amputation. As the skin regenerates it is shiny, pink, and dry. Sensation in it is usually impaired, and the part may be unusually sensitive to cold for an indefinite period.

Prophylaxis

The prophylaxis of frostbite in aircraft consists of the proper use of clothing (see below), adequate indoctrination of the crews regarding the dangers of climatic stresses, and lastly, the construction of military aircraft to reduce the exposure of occupants to wind and cold.

Treatment

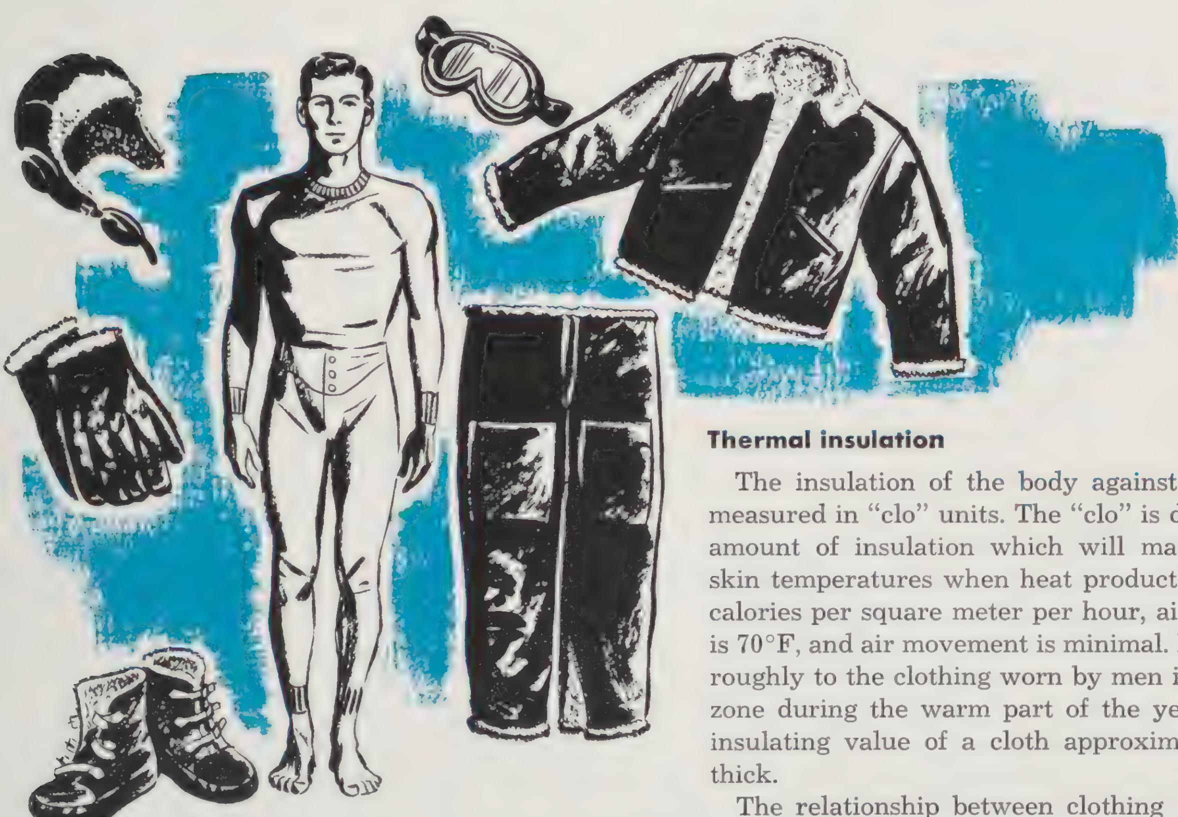
Those tissues which have actually undergone solidification will be lost at least in part because they are

usually non-viable. The objective of therapy, therefore, in the early stages is to restore circulation to tissues which have been injured but which still retain viability. Unfortunately, these are the tissues which show the greatest degree of reactive hyperemia. There is some difference of opinion on how rapidly the thawing process should be carried out and what measures, if any, should be undertaken to abolish any marked vasoconstriction that may persist once thawing is complete. The controversy is concerned with the matter of allowing the part to become warm at "room" temperature or of actually applying cold in order to limit the amount of circulation to the part and hence the degree of reactive hyperemia. It would appear that each case is individual in this regard and that rational therapy will depend upon the degree of hyperemia and edema, and on the severity of the patient's symptoms. If all of these are extensive, limitation of circulation by application of cold and elevation of the part have been advocated. As an alternate procedure aseptic aspiration of edema fluid and blebs followed by application of a pressure dressing is also used.

The use of drugs, heat to the trunk, and blockage of sympathetic nerves or ganglia to restore circulation to the part will likewise depend upon a consideration of the factors mentioned above. A stimulating dose of tetanus toxoid is desirable in all cases of frostbite. Smoking should be avoided in view of its well known limiting effect on peripheral circulation. Alcohol by mouth is a desirable therapeutic measure if the indications are for restoration of the circulation rapidly. Locally, the part is best handled with dry sterile dressings, although one of the sulfonamides may be included in powdered form.

Once the phase of hyperemia has passed, then all measures should be directed toward increasing the circulation to the part in order to promote demarcation and healing. Such measures should include alcohol by mouth, Buerger's exercises, and perhaps repeated sympathetic blocks with novocain or related drugs. Amputation of obviously necrotic tissue should be accomplished only after the line of demarcation is well marked.

PROTECTIVE CLOTHING

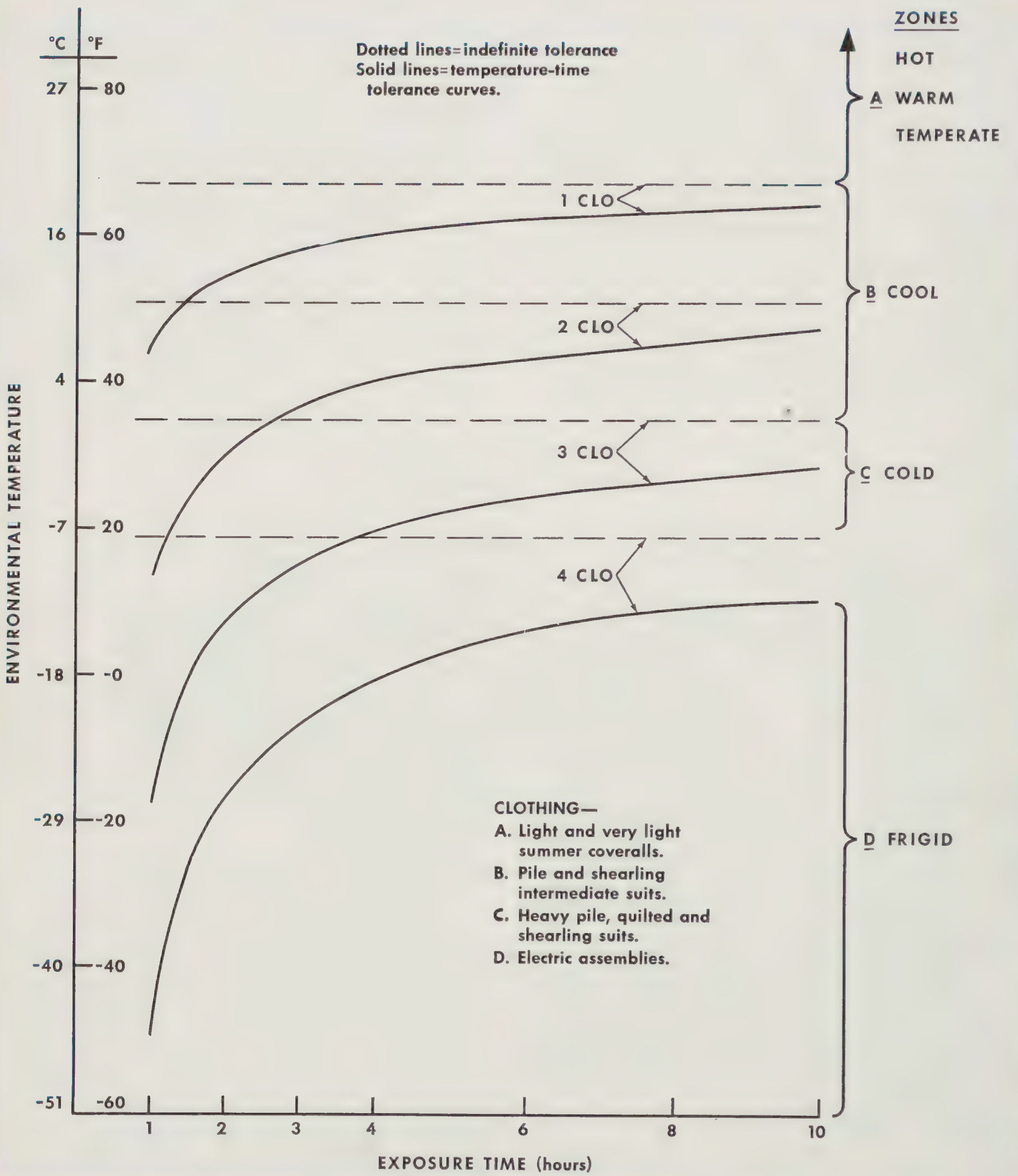


Thermal insulation

The insulation of the body against cold may be measured in "clo" units. The "clo" is defined as that amount of insulation which will maintain normal skin temperatures when heat production is 50 kilocalories per square meter per hour, air temperature is 70°F, and air movement is minimal. It corresponds roughly to the clothing worn by men in a temperate zone during the warm part of the year. It has the insulating value of a cloth approximately 0.42 cm thick.

The relationship between clothing (in clo units) required for various environmental temperatures is shown in the figure. Two facts stand out in this graph:

COLD TOLERANCE CURVES WITH CLOTHING



1. The thermal insulation of the clothing determines the temperature which can be withstood in comparative comfort for a 6 hour period or longer, but for shorter exposures protection is afforded to much lower temperatures.

2. The limit of insulation with clothing is placed at 4 clo because such clothing is about one inch thick, and reaches the practical limit of permissible bulk and weight.

Wind proofness

If wind penetrates the surface of clothing or enters openings at the neck, waist, sleeve, or trouser cuff, as much as 30% of the insulation intrinsic in the garment may be lost through forced convection of the entrapped air. Wind proofness of the surface clothing depends upon tough, close-woven, shell materials of long staple cotton. Adequate closures should be provided.

Thermally adequate foot-gear and hand-gear

High surface-to-volume ratios and thermo-sensitive variations of blood flow to the extremities predispose them to rapid and extreme cooling. Practical coverings may seldom exceed 2 clo because of physical limitations. This maximum of protection is reached in footgear by the use of adequately large shoes or boots and several pairs of woolen sox. Suitable gloves are a compromise between the opposing requirements for insulation and dexterity. The practical solution lies in selecting the thickest glove which will permit necessary manipulative tasks to be performed and in supplementing this with warming mittens donned when fine dexterity is not required.

Electrically heated clothing

The electric suit-assembly is far superior to exclusively insulative clothing for cold protection in aviation, because:

1. It provides complete protection in the frigid zone.

2. It assures adequate thermal protection for the hands, and for the feet, and permits the use of gloves of feasible dexterity.

3. Its bulk and weight are within reasonable limits.

AAF electric assemblies furnish insulation sufficient to meet the requirements of the intermediate zone without heating, but protection extends to —48°C when full power is utilized. Thus, in the event of power failure, reasonable thermal adequacy is maintained for one hour at —40°C.

Warm and hot zone clothing

From 30°C up to the temperature-humidity limits of human tolerance clothing of very light weight is used. The effect of such clothing upon heat tolerance is small, provided the clothing is permeable to vapor. In hot-humid conditions little or no effect of light weight clothing is found, but in the hot-dry range, and with the additional load of solar radiation, clothing serves to increase heat tolerance. Here, insulation reduces the inward transfer of heat by radiation and convection, while evaporation loss is little impaired. This furnishes an explanation for the custom among desert peoples of wearing light weight but flowing garments which keep the head and body well covered.

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EFFECTS OF MOTION

AIRSICKNESS

Definition

Airsickness is a symptom complex which results from alterations in the speed and direction of motion of an aircraft. It is a form of motion sickness and is analagous to seasickness, trainsickness, carsickness, roller coaster sickness, and swingsickness.

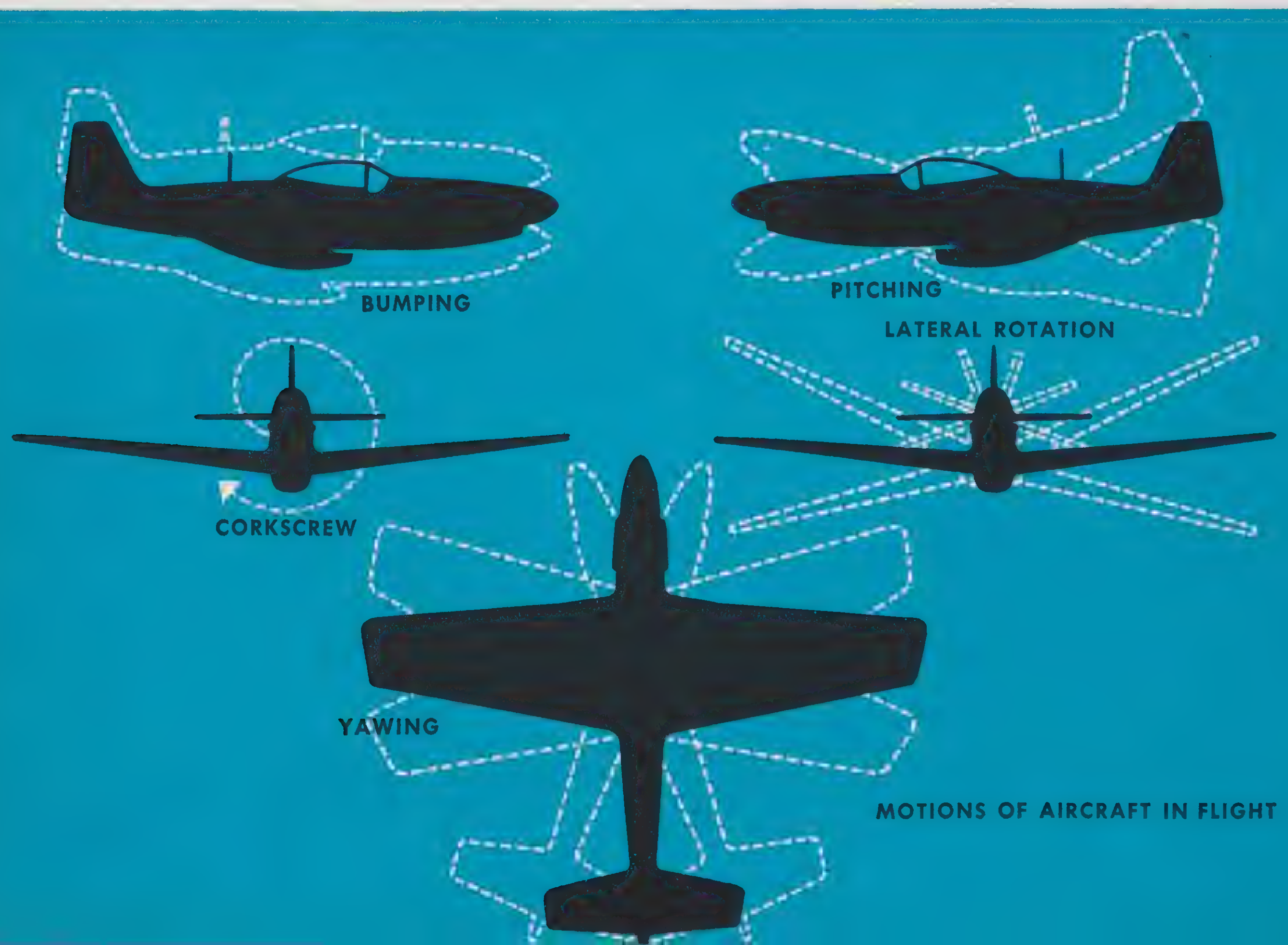
Etiology

Predisposing. Every individual is susceptible to airsickness when the motion of the aircraft is of sufficient degree, or is prolonged, or both. This individual susceptibility varies within wide limits without adequate explanation. Any factor which minimizes the number of sensory stimuli reaching the brain stem decreases susceptibility.

The sensory stimuli from motion reaching the brain stem arise from the vestibular apparatus, the eyes, the joints and muscles, the viscera, and the vascular system. The normal threshold of susceptibility is generally high in emotionally stable individuals and low in unstable races and types. It may be lowered temporarily, and at times permanently, by apprehension, anxiety, fear, fatigue, organic diseases, especially of the gastro-intestinal tract, dietary indiscretions, and alcoholism. Visual disorientation and labyrinthine stimulation such as occur in instrument flight either lower the threshold to motion or actually cause vomiting without accompanying motion.

In bad weather all members of a combat crew may become airsick while the pilot remains immune. His relative immunity under these circumstances is attributed to his feel of the aircraft on the controls. He is thus able to anticipate part of the motion and make bodily adjustments accordingly.

Exciting. The primary factor in the production of airsickness is the motion of the aircraft in flight. This motion includes lateral rotation, scending, pitching, yawing, and any combination of these. Such motion is exaggerated by such factors as atmospheric disturbances, design of the aircraft, distribution of the load, efficiency of the pilot or automatic pilot, aerobatics, combat flying, and the position of the individual relative to the center of rotation of the particular aircraft.



MOTIONS OF AIRCRAFT IN FLIGHT

Incidence

Between 10% and 15% of all flying trainees become airsick at least once during the training period but only 5% are airsick more than once. The elimination rate because of chronic airsickness is 0.5% to 1.5% for all individuals taking training for a rating of pilot, bombardier, or navigator.

Classification

Airsickness may be classified on the basis of the severity of the symptoms. The majority of individuals are susceptible in such *mild degree* that it does not interfere with their flying activities. In these, airsickness will occur only in rough weather or during aerobatics; the symptoms will be completely relieved by vomiting; there are no side effects or persistence of symptoms after cessation of motion; and with repeated flights, immunity to airsickness develops.

A small percentage of individuals will have airsickness to such a *marked degree* that it will interfere with flying duties. In contrast to the first group, these individuals will be airsick in smooth weather as well as in rough weather; no relief will be experienced by vomiting; side effects and persistence of symptoms after returning to the ground are common; and regardless of the amount of flying done, immunity to airsickness never develops.

Symptoms

The usual order of symptoms is an epigastric awareness gradually progressing to nausea, salivation, pallor, sweating, and possibly yawning. The individual loses his general feeling of well being and if the stimulus continues, he feels so wretched that volition disappears, any constructive task is impossible to accomplish, and vomiting occurs. Headache and vertigo may be present. The act of vomiting may temporarily relieve symptoms but another cycle may occur. There are no important changes in pulse rate, blood pressure, blood chemistry or respiration. Loss of gastric tone and decrease of gastric peristalsis associated with pylorospasm occurs.

Prophylaxis

The plane. Complete prevention of airsickness in military aircraft is impossible because of design of the aircraft and the inclement weather in which missions must often be flown. At times, however, the mission may be modified so that smoother air will be encountered. During a variable proportion of the flight, personnel should be permitted to ride in parts of the plane where motion is at a minimum. Violent and unnecessary maneuvers should be avoided as much as possible. The future design of aircraft with relatively stable flying characteristics must be considered.

Personnel. Selection of personnel is the best method of eliminating airsick individuals from military aviation. Individuals with a history of susceptibility to other types of motion sickness or to airsickness must be carefully evaluated from a psychological and psychiatric point of view. As part of their study, a test for motion sickness is of some value. Observations on airsickness during orientation flights will help in eliminating highly susceptible individuals.

Indoctrination of instructors, especially primary school instructors, on the need for the gradual introduction of the student to the unfamiliar motion of aircraft, is an extremely valuable prophylactic measure. It appears that once an individual is airsick, his threshold to motion is lowered. If a new student is subjected to violent aerobatics on his first flight, his threshold may be lowered to such a degree that he is lost to the training program.

Food and drugs. There is great individual variation in the matter of airsickness in relation to a full or empty stomach, and to the ratio of fluid to solid food taken immediately before or during a flight. Each individual seems to have his own favorite feeding schedule.

Drug therapy is aimed at preventing the symptoms in the individual with mild airsickness until he becomes conditioned to the motion of the aircraft. Once immunity has developed, the treatment may be discontinued. In contrast, drug therapy is of little value in the treatment of the individual with severe airsickness.

The drugs used in the treatment may be divided into two groups: the central nervous system depressants such as the barbiturates, and the parasympathetic depressants such as hyoscine (see Section 8-13).

The barbiturates now in use cause too much depression of the central nervous system to be safe in the prevention of airsickness in crews of military aircraft. However, they may be used to alleviate airsickness in passengers who do not have responsible duties during or after the flight.

Hyoscine hydrobromide is the most effective of the parasympathetic depressants in the prevention of airsickness. It is usually given one hour before flight and probably should not be repeated more frequently than once every 6 hours. The dose of the hy-

drobromide is 0.75 mg. The drug should be used with caution in hot climates as it inhibits sweating. In large doses, it also paralyzes accommodation of the eyes, but in therapeutic doses such as recommended, this complication is not encountered.

Treatment

Once airsickness has occurred in flight, the most effective treatment is return to the ground. Recumbency or semi-recumbency, improved ventilation, and the use of drugs as indicated above may help.

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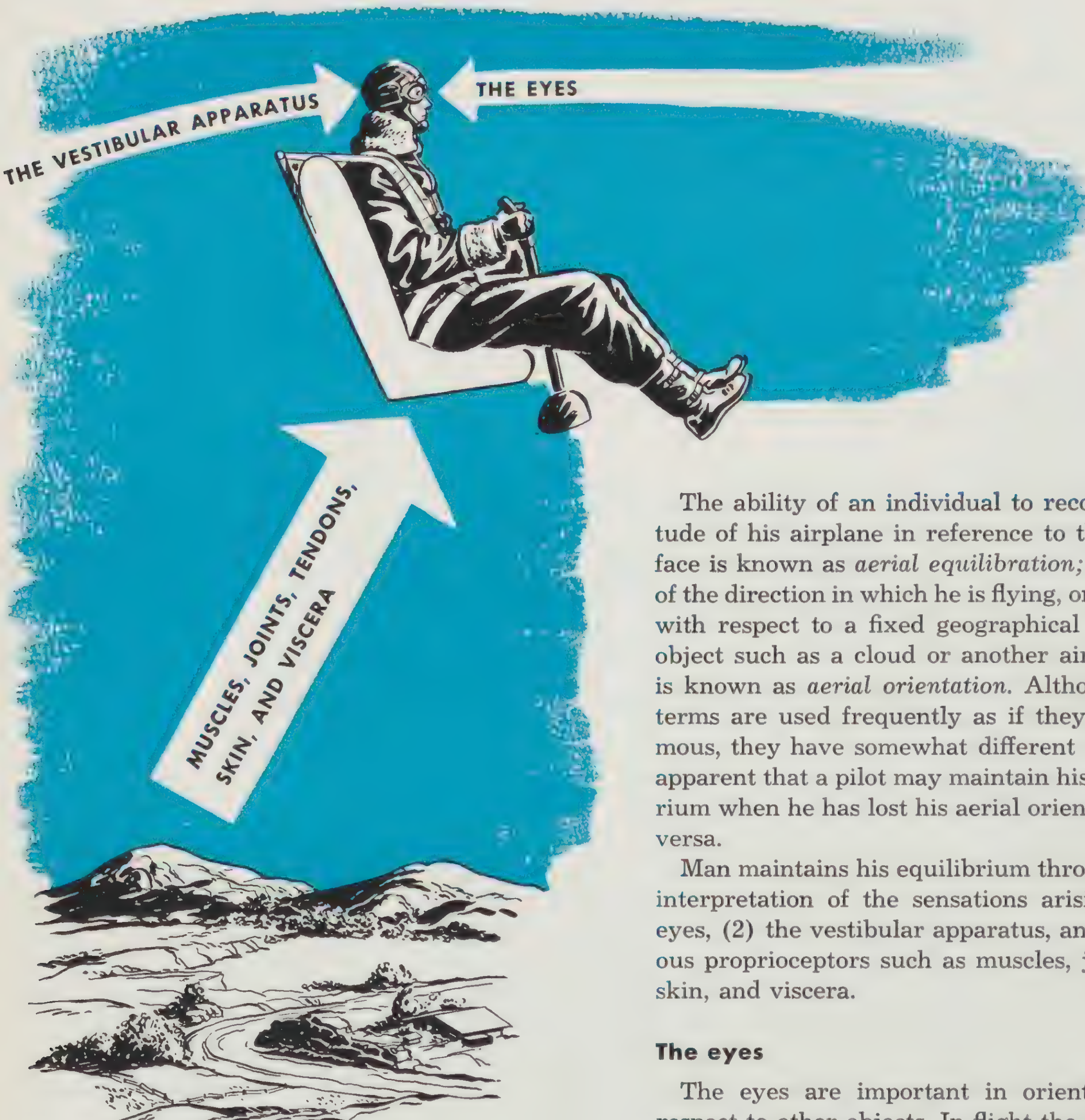
SENSORY ILLUSIONS IN FLIGHT



The ability of an individual to recognize the attitude of his airplane in reference to the earth's surface is known as *aerial equilibration;* the awareness of the direction in which he is flying, or of his position with respect to a fixed geographical point or some object such as a cloud or another airplane in flight is known as *aerial orientation.* Although these two terms are used frequently as if they were synonymous, they have somewhat different meanings. It is apparent that a pilot may maintain his aerial equilibrium when he has lost his aerial orientation and vice versa.

Man maintains his equilibrium through the proper interpretation of the sensations arising in (1) the eyes, (2) the vestibular apparatus, and (3) the various proprioceptors such as muscles, joints, tendons, skin, and viscera.

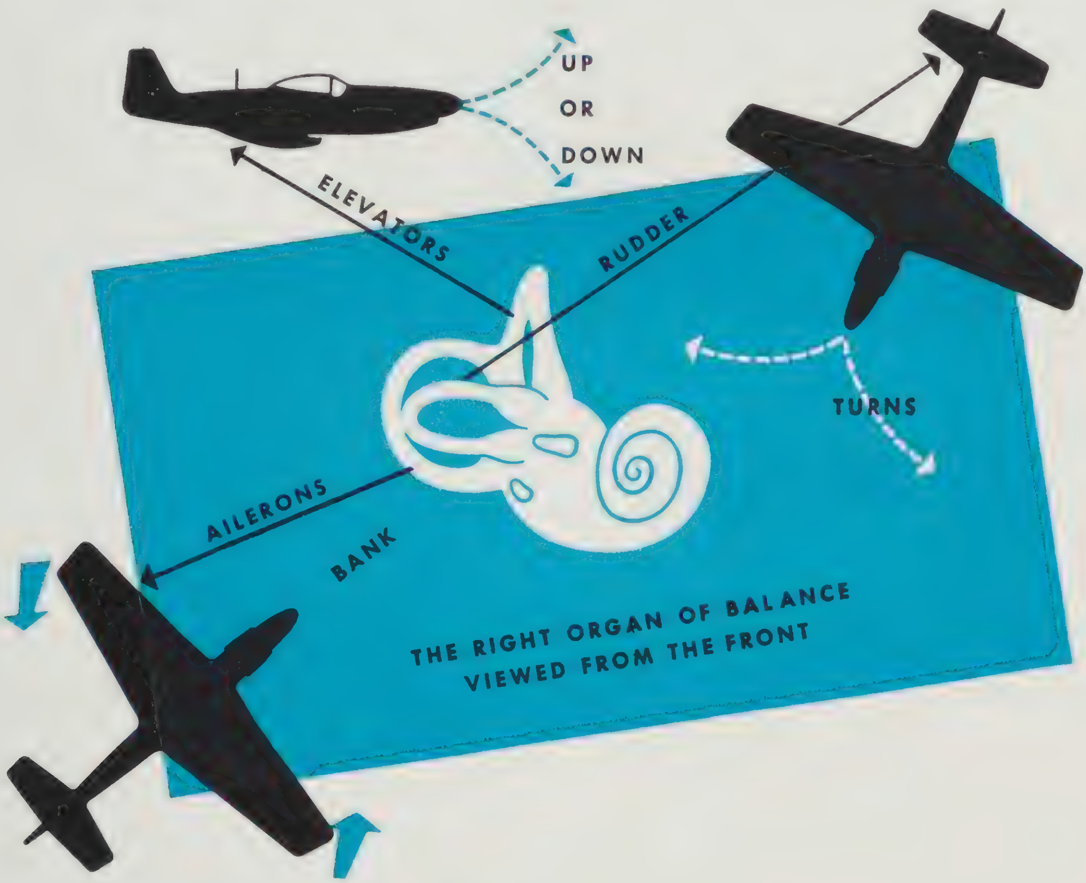
The eyes

The eyes are important in orienting man with respect to other objects. In flight the horizon is usually the "other objects." While flying in clear weather aerial equilibrium may be maintained by direct observation of the ground and horizon.

The vestibular apparatus

The vestibular apparatus is located in the bone of the inner ear. It consists of three fluid containing semicircular canals connected to an irregular sac-like organ known as the utricle. The canals are arranged at right angles to each other in the vertical, horizontal, and transverse planes. Movement of the head results in movement of fluid in a pair of canals or combination of canals in the plane or planes of movement. For example, nodding results in movement of fluid in the vertical canals. Similarly, changes in the direction of the aircraft may cause movement of the fluid in the semicircular canals. Vertical changes resulting from use of the elevators affects the vertical canals; banking from use of the ailerons affects the transverse canals; and turning from use of the rudder affects the horizontal canals.

In the ampullae, or dilated ends of the canals, are located hair-like projections which extend from the wall into the fluid in the canals. Because of the inertia of the fluid, it tends to lag behind the movements of the head much as fluid in a glass at first will remain stationary if the glass is rotated quickly. This inertia of the fluid deforms the hair-like projections and initiates neural impulses which are interpreted as movement. The acceleration necessary to stimulate the vestibular apparatus is 12 cm per sec per sec linearly or 2° per sec per sec angularly. Motions with less acceleration than these minimal limits will not be detected by the end organ. Changes in direction of motion of aircraft must have comparable accelerations in order to be detected by the pilot. If the rate of rotation of a plane about any of its axes is less than 2° per sec per sec, the vestibular apparatus will not be stimulated and the sensation of turning will not occur.



Returning to the analogy of the rotating glass of water, if the glass is stopped, the water will continue to rotate. A similar condition is said to exist in the semicircular canals. If the fluid is set into motion and the motion of the head ceases abruptly, the fluid

will continue to move in the canals. This continuance of motion produces the same sensation as moving the head in the direction opposite to the original direction. Hence there is a sensation of turning in the opposite direction.

Inspection of these phenomena reveals the possibility of many false sensations arising in flying, especially instrument flying or flying at night. The vestibular apparatus can not be relied upon for aerial equilibrium in these situations.

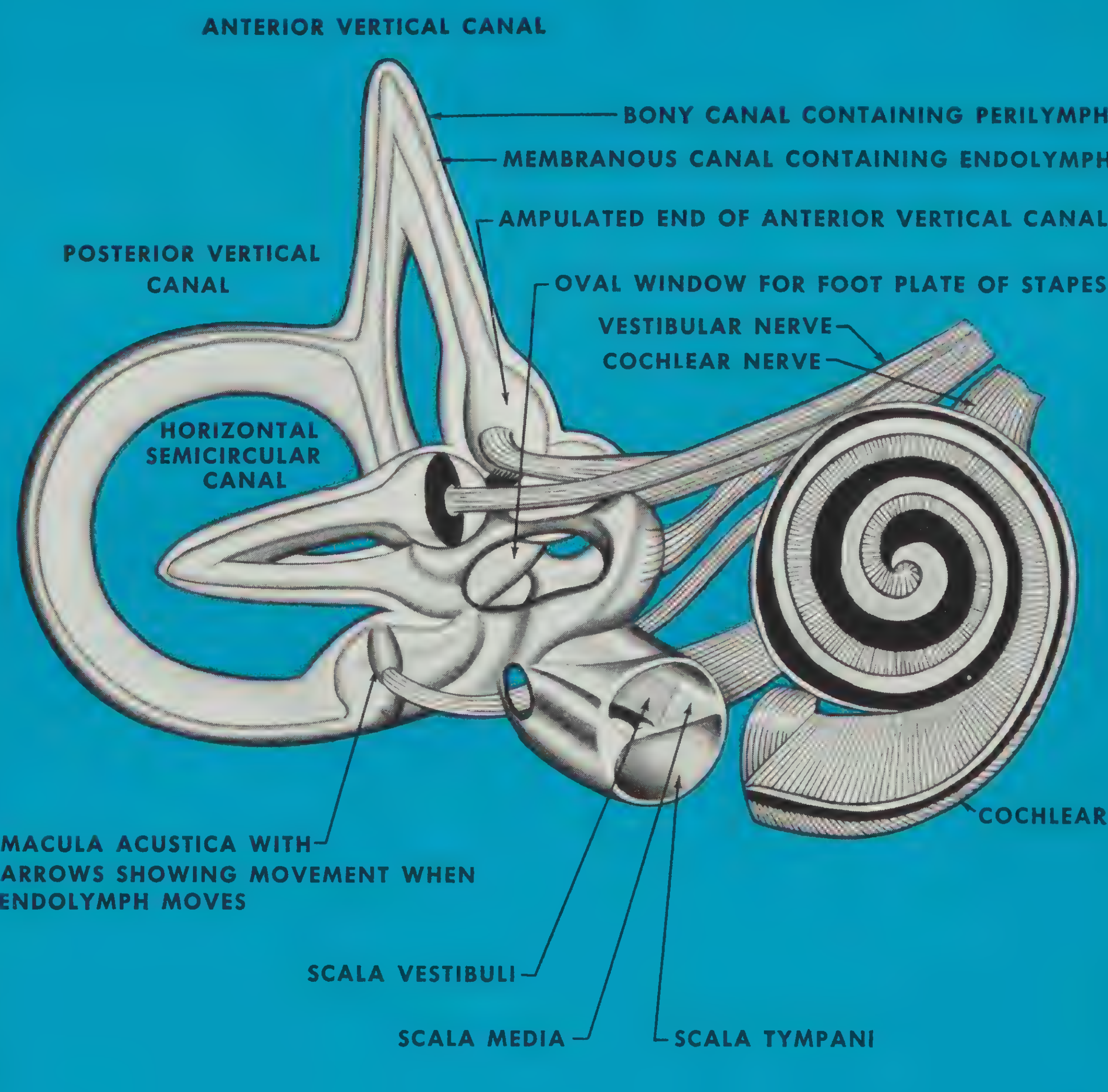


DIAGRAM SHOWING STRUCTURES OF RIGHT INNER EAR

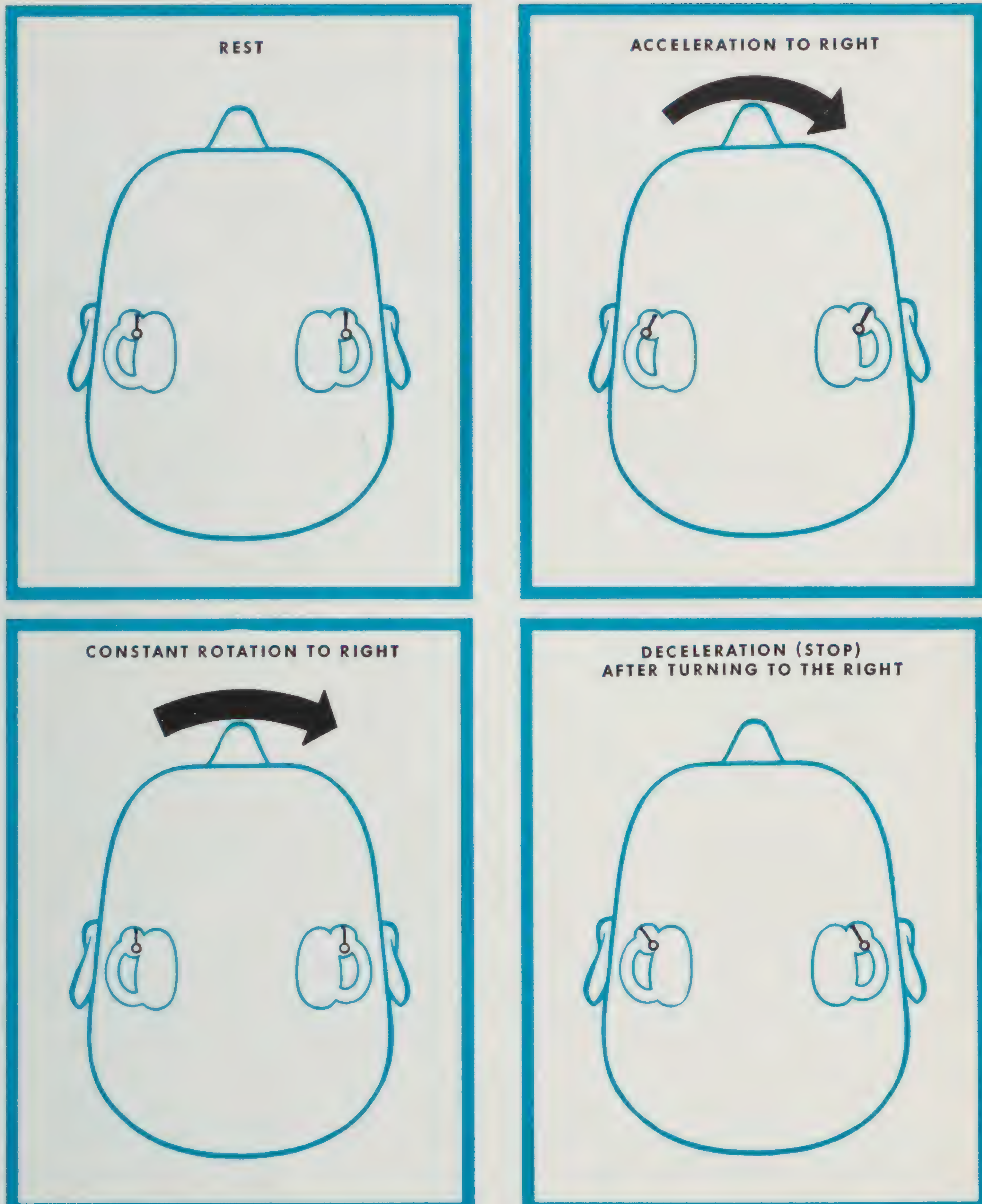


Diagram of Horizontal Semicircular Canals Illustrating Effect of Rotation and Fluid Inertia on the Ampullary End Organ.

The utricle, or so-called static organ to which the semicircular canals are connected, contains numerous hair-like nerve endings to which are affixed tiny crystals or otoliths. The sensations arising in the utricle, together with sensations from proprioceptors in the neck and shoulders, are interpreted and recognized by the individual as various positions of the *motionless* head. In the upright position the hair-like endings in the utricle are not deformed. However, if the head is tilted the nerve endings are stimulated by the deformation resulting from a change in the direction in which the force of gravity is acting upon the hair cells.

Any motion which will reproduce the change which occurs when the head is moved to a new position will give rise to the sensation of having the head tilted. Such a reproduction may occur in flight, for example, in a skid. A level skid to the left will produce a force which is interpreted as having the head tilted to the right. A similar illusion may be produced in a slip.

The proprioceptors

The proprioceptors are responsible for the sensations which arise from pressure on or from movement of a joint or muscle. This "deep sensibility" enables man to point, sit down, or walk, with the eyes closed. It is responsible for the knowledge of where an extremity is in space. In flying, the individual is usually seated, and the forces exerted upon him are such that with training he can tell many movements of the aircraft by the pressure of the seat on his body. An increase of this pressure occurs in climbing, and any maneuver which produces pressure against the seat will be interpreted as climbing. In descent he is pressed less firmly into the seat than in normal flight, and consequently any maneuver which reduces pressure on the seat will be interpreted as descending. In a slip or skid the pilot is forced sideways in his seat. Since this impression usually results from tilting, he will have the impression of tilting in the direction away from the slip or skid.

Illusions in flight

From the foregoing it is clear that with the exception of vision the mechanism man has available for maintaining equilibrium may easily mislead him under certain circumstances. Some of the more common "sensory illusions" which may be experienced in flight, particularly when the horizon is not visible, are as follows:

Illusion of Tilting (the "leans"). Rotation of the head must occur at a certain minimum rate in order to be detected by the semicircular canals. If during blind flight an aircraft tips to one side quickly enough for the pilot to detect it but is restored to straight and level flight slowly enough that he does not detect it, he may believe that his aircraft is still tilted to that side. The sensation will be so convincing that he will actually lean away from the supposed tilting even though his instruments may tell him that his aircraft is in straight and level flight. Because of this tendency to lean from the side of the original tilt, this phenomenon, which is a common one during instrument flight, has come to be known as the "leans." The converse may happen. An aircraft may gradually tilt to one side and be undetected. When recovery from this tilted attitude is made abruptly the pilot may interpret it as a wing low on the opposite side and he may lean in order to align himself with the supposed axis of the plane.

Illusion of Turning. A gradual turn may be undetected. If suddenly corrected, it may give the impression of turning in the opposite direction, for the fluid in the involved semicircular canals continues to move in the direction of turn once the head and indeed the entire aircraft are restored to the original line of flight. Here again the original gradual stimulus of turning was insufficient to cause any sensation but with a cessation of turn there was sufficient deceleration of the fluid in the semicircular canals to actually stimulate the nerves there, and to give a false impression of turning in the opposite direction.

This particular illusion is greatest in the spin, for in this maneuver the rotation of the head and of the fluid in the semicircular canals is rapid. When the spinning airplane is stopped abruptly, the false sensation of turning in the opposite direction is so convincing that the aircraft may be spun again in the original direction by overcontrolling.

While turning blind, if a pilot should put his head down in the cockpit, a sudden stimulation of a semicircular canal just brought into this plane of motion will give him the sensation of a snap-roll or abrupt increase in the turn.

Illusion of Climbing or Descending. Deep sensibility may confuse the pilot either in straight and level flight or when turning. An up-draft may increase the pressure on the seat and give him the illusion of climbing such as results from pulling the stick back. Likewise a down-draft may decrease the pressure on the seat and give him the sensation of descending just as occurs when the stick is thrown forward. In a well executed turn without any slip the increased pressure on the seat again will give the false sensation of climbing. Once the turn is completed and the plane has leveled out, the decreased sensation of pressure on the seat may give the illusion of descending or diving.

Illusions of vision may occur by day or by night. The most common one that occurs during daylight is a feeling of tilting when flying between two cloud banks of different slope, the two banks sloping toward each other and at the same time obliterating the horizon from view. At night the horizon is usually invisible. The pilot may be able to see only isolated points of light. His sensations may tell him that these lights are in a certain position with relation to the aircraft when actually they may be in an altogether different position. It is known that pilots have actually confused stars with lights on the ground.

Another illusion of vision which occurs at night is called *autokinesis.* This is a sensation which occurs when an individual stares at one light for a long period of time. Eventually the light will appear to move, although actually it has not. The illusion may occur while flying as wing man during formation flying at night. While staring intently at this light, autokinesis may occur and the light may appear to move up or down. Sometimes this illusion may be so vivid as to lead the pilot to believe that the lead man has made a sudden bank of his aircraft when actually he is flying straight and level. This may result in his turning away from or sharply toward the lead plane with resultant disastrous effects. This illusion may be avoided by not staring continuously at the wing light of the lead plane.

Dissociation of consciousness

A situation arises in flight which can not be classed exactly as an illusion but which nevertheless is dangerous. It is similar to a hypnogogic state and erroneously is called *autohypnosis.* It results from being over-attentive to the instruments which, coupled with the hypnotic effect of the drone of the motor, the monotony of the radio beam and other sounds, causes the pilot to become inattentive to such factors as the attitude or orientation of his plane.

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ACCELERATION IN AIRCRAFT

Classification

An increase in speed or a change in direction of a moving body is called acceleration. Since either or both of these variables may be altered there are three types of acceleration:

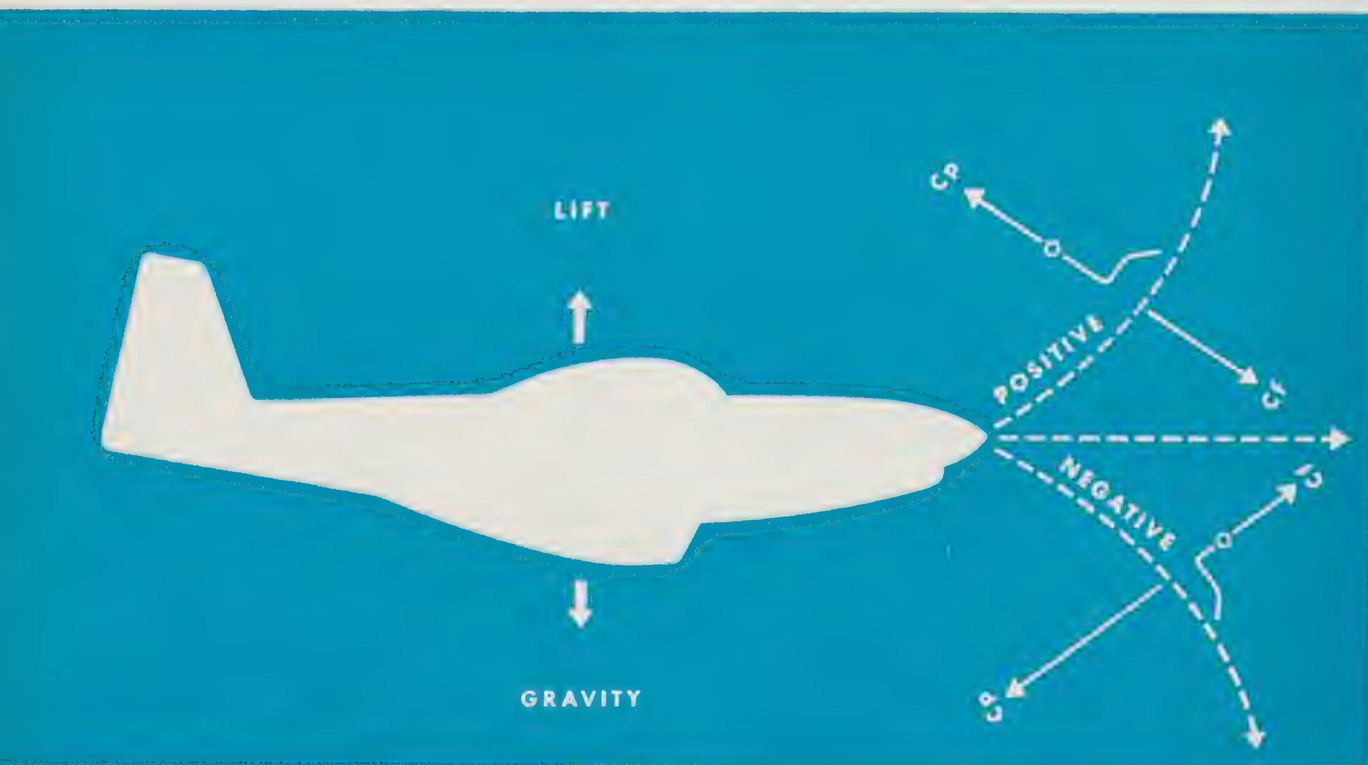
	Change in Rate	Change in Direction
Linear	+	0
Radial	0	+
Angular	+	+

Radial acceleration in aircraft is usually classified further. When the force producing the change in direction is applied to the under surface of the airfoil, "positive" acceleration is said to have occurred and the force of inertia acting on the occupant from head to seat is expressed in positive gravitational units as "+g." If the change in direction of motion of the aircraft around its horizontal transverse axis is a result of a force applied to the upper surface of the airfoil "negative" acceleration is said to have occurred, and the force of inertia acting on the occupant's body from seat to heat is expressed in negative gravitational units as "—g."

Linear velocity, acceleration, and deceleration

Progressive increase in velocity along a straight line is called linear acceleration. If, on the other hand, speed is progressively decreasing, linear deceleration has occurred.

Incidence. Linear acceleration in aircraft occurs especially on take-off, and is greatest on take-off from a catapult. Linear deceleration occurs especially on landing. The most abrupt decelerations are encountered in aircraft landing on the deck of a carrier, in the crash landing, in the crash, and on ditching.



Acceleration in aircraft. In positive acceleration the applied force (Cp, centripetal) is to the under surface of the airfoil, and the inertia of the pilot's body is in the opposite direction (Cf, centrifugal) acting from his head to his seat. A reversal of these forces occurs in negative acceleration. Transverse acceleration occurs when velosity is increased or decreased in level flight. In an arrested landing the applied force (A, solid arrow) is from front to back, with the force of inertia (I, broken arrow) acting from back to front. A reversal of these forces occurs in the catapult takeoff. Note that when an aircraft changes its direction, the forces Cp and Cf do not replace lift and gravity but occur in addition to them.

Abrupt linear deceleration is also encountered on opening a parachute in flight, and on striking the ground after a parachute jump.

Measurement. A force is required to move a stationary body or to stop a moving body. This force is conveniently measured in "g," the acceleration of gravity, which is 32 feet per second per second or 9.6 meters per second per second. When acceleration or deceleration is strictly linear, a circumstance which probably rarely occurs in aviation, the forces involved depend upon the change in velocity and the distance through which this change occurs. It can be expressed as: $la = \frac{(V_2)^2 - (V_1)^2}{2S \times g}$ where la is linear acceleration, V_2 is the final velocity, V_1 the initial velocity, S is the distance through which the change in velocity occurs, and g the acceleration due to gravity.

It is apparent that the greater the distance through which a change of velocity occurs the smaller the force involved.

Physiological effects. There appears to be no limit to the speed with which the human body can travel provided it is protected from the wind.

Considerable linear acceleration can be applied without detriment provided it is applied relatively evenly to the entire body. In the catapult take-off, for example, the head must be well supported.

The effects of linear deceleration depend, among other things, upon the size of the forces involved, the manner in which they are applied to the body, and the area of the body to which they are applied (see Section 8-9).

Prophylaxis. Prophylaxis against injury from linear velocity and acceleration consists of protection of the body from the slip stream, and the even application of accelerative forces to large areas of the body. Prophylaxis against injury from linear deceleration resolves itself into 3 principal components:

1. Increasing the decelerative distance.
2. Distributing the decelerative force over a large area of the body.
3. Reducing initial velocity.

These objectives may be accomplished in a variety of ways which require close cooperation of the medical officer, the personal equipment officer, and the aeronautical engineer. Ways in which they may be attained at present are:

1. Use of safety belts and shoulder harness.
2. Proper position and location in aircraft on landings and takeoffs.
3. Abolition of projecting parts.
4. Use of crash helmets and cushioning devices.
5. Construction of cockpits of such strength as to resist disintegration when forces are applied which can be withstood by man.
6. Indoctrination of crews in the use of safety devices, crash landing procedures and ditching procedures.

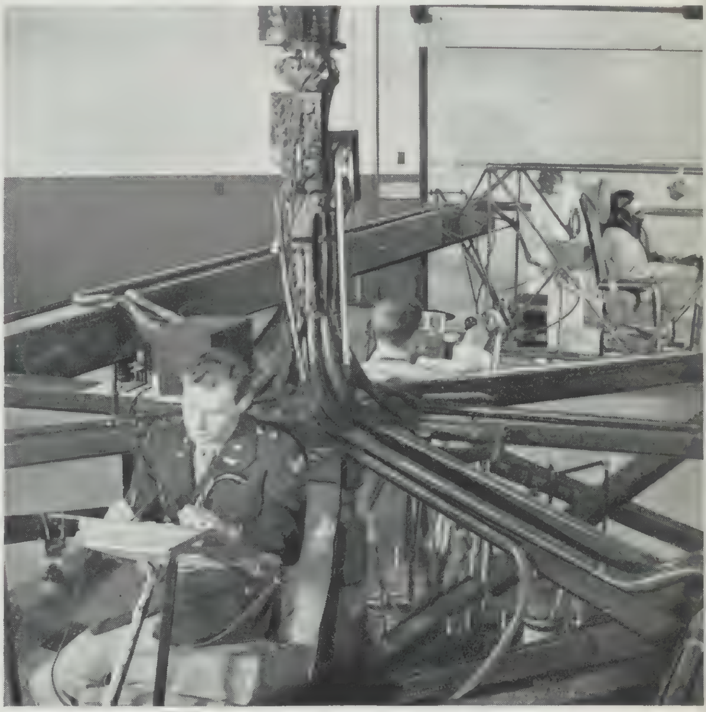
Radial acceleration

To change the direction of motion of an aircraft in flight a force is necessary which is called the centripetal force. This force is opposed by the inertia of the airplane and its contents which is called the centrifugal force. These two new forces occur in addition to the others acting on the aircraft in flight, and any precise measurements must take into consideration the latter as well as the former.

Physiological effects of radial acceleration will depend upon the direction of the applied force, as well as on other factors.

Positive acceleration.

1. Many of the effects are attributable to the apparent increase in the weight of the body as greater force pulls on it. There is a sensation of being compressed in the seat ("concertina action"), and of heaviness of the hands. The soft tissues of the face are pulled downward from the facial bones causing

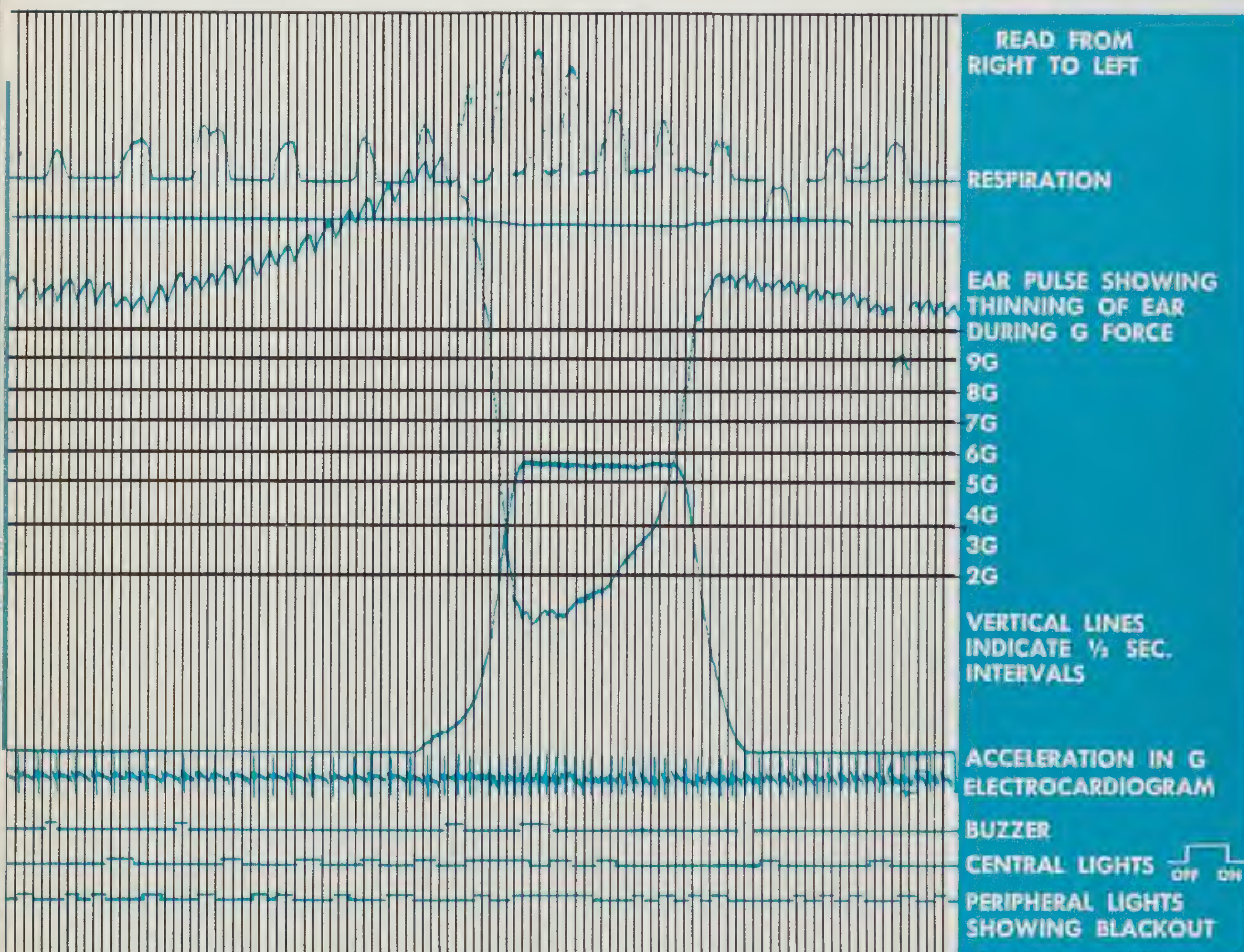


a drawn, haggard appearance. Relaxed subjects sitting erectly in a conventional cockpit on a centrifuge perceive dimming of vision during 10 seconds at +3 to +4g, tubular vision (loss of peripheral vision) at +3.5 to +5g, complete blackout (blindness or "amaurosis fugax") at +4 to +5.5g, and unconsciousness at +4.5 to +6g. Of tactical importance is the realization that in stages of dim, tubular and blacked out vision the pilot's orientation for time and place is preserved and a return to normal vision occurs in 3 to 5 seconds after the force abates. Return to consciousness, once lost, does not occur for 15 seconds to 1 minute and is accompanied briefly by complete disorientation. During unconsciousness, dreams are common and previously planned patterns of action are lost. Therefore, there is a striking difference between blackout and unconsciousness. Symptoms are modified by the following factors:

a. Duration of the force. The force up to 10g, must act for at least 3 to 4 seconds to produce symptoms. Further, the symptoms will develop fully during 6 to 10 seconds of exposure to the force. If a moderate force persists beyond this time the symptoms may abate.

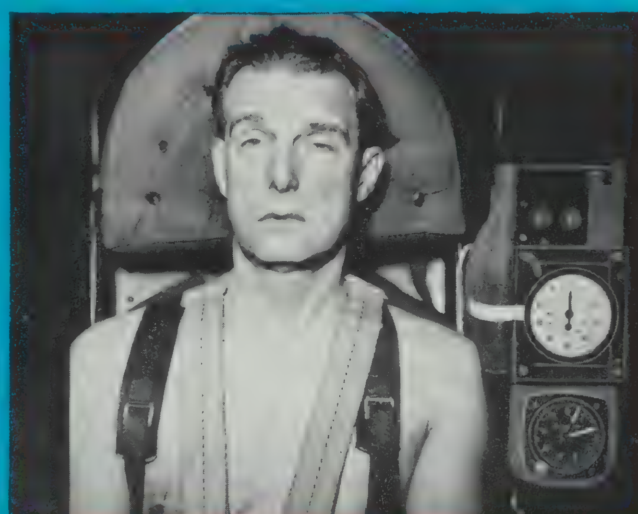
b. Rate of onset of force. If the onset is gradual, that is, less than 2g per second, the full play of symptoms is perceived by the pilot; namely dimming, tubular vision and blackout is an orderly sequence before unconsciousness supervenes. In a snap pullout, where the force develops at a rate of 3 to 10g per second, the sensorium is apparently overwhelmed and unconsciousness may occur without initial visual disturbances.

A similar precipitant passage from clear vision to



At 2.2 g subject experiences no reduction in visual acuity, little discomfort.

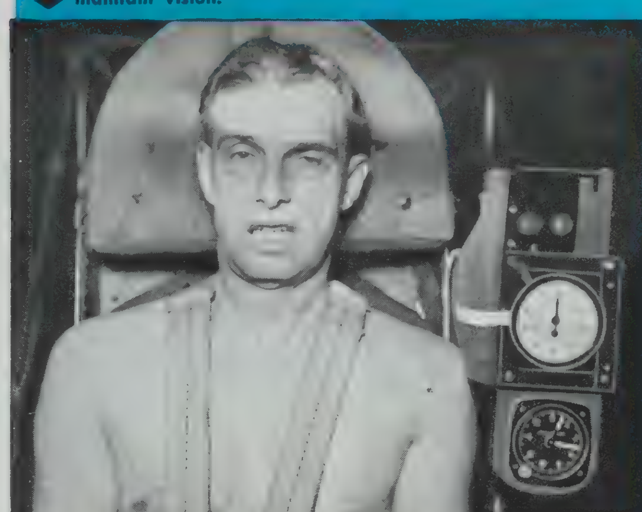
At 3 g strain is evident in facial distortion; dimming of vision is noticed.

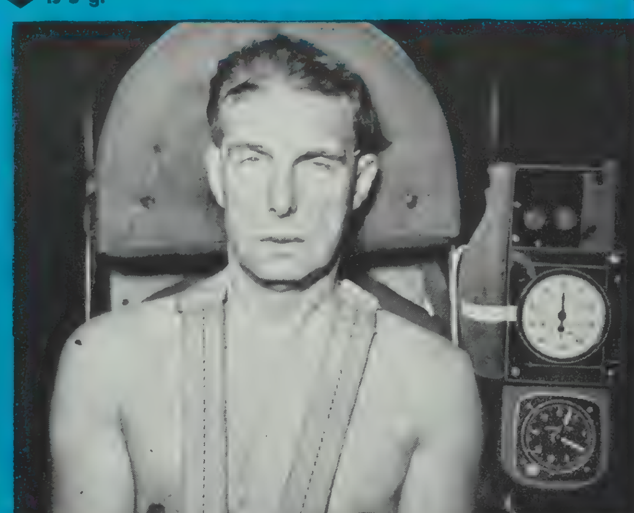


At 4 g facial distortion is marked; peripheral vision lost. Subject is fighting g.

At 5 g peripheral vision lost, central vision greys; he shouts to maintain vision.

At 6 g subject is fully conscious but blacked out. Average tolerance is 5 g.





unconsciousness may occur in subjects who are very tense and frightened On the centrifuge the subject may at 5-minute intervals withstand successfully 4, 5 and 6g for 10 seconds each, only to become unconscious on the fourth run at 7g without having experienced dimming.

c. Blood pressure. There is evidence that the blood pressure which exists before exposure to centrifugal force influences the g-resistance displayed by the pilot. Procedures like tensing the muscles or performing a modified Valsalva maneuver such as yelling or grunting tend to activate pressor reflexes.

d. Emotion. Fear, with the accompanying rapid heart rate and high blood pressure, and perhaps tenseness increase g-tolerance most likely by increasing the blood pressure.

e. Position in the aircraft. A popular misconception is that the passenger in the rear seat of a two-seated aircraft blacks out more easily because he has a larger force acting on him. The reason for any difference that may exist is probably attributable to the fact that the pilot is forewarned of the instant he will pull out. His voluntary tensing of muscles and other empirical anti-g reactions are brought into play at the right moment to be most effective. The passenger, on the other hand, sits unwarned and must take the force without preparation.

f. Experience: A pilot's resistance to g probably becomes better with experience because he develops a compensatory "reflex" to g, consisting of crouching, tensing the muscles, particularly abdominal muscles, straining, and yelling. On the centrifuge a subject's g-tolerance on repeated daily exposures usually falls. This is attributed to his becoming accustomed to the weird sensations and motion of the centrifuge and to the feeling that even if he does blackout there is no danger such as there would be in an aircraft in flight.

g. Condition of flying personnel. There is some evidence to indicate that g-tolerance is reduced by such factors as inadequate sleep, fatigue, anoxia, alcohol and tobacco in excess, and illness.

h. Velocity and radius of turn of the aircraft. The force involved in radial acceleration is directly proportional to the square of the speed and inversely proportional to the radius of the turn.

2. Pathological physiology. The usually accepted primary cause of blackout is abrupt enemic anoxia of the brain as a result of sudden cessation of circulation to that organ. This failure of circulation was earlier attributed to a diminished cardiac output which in turn was alleged to be due to failure of cardiac filling. It was thought that dilatation and increased content of the veins below the heart was caused by the increased hydrostatic pressure as a result of positive radial acceleration.

The principal objection to this theory is that this process of venous pooling is probably too slow to account alone for blacking out in 3 to 5 seconds. Further, studies of the heart fail to support the early conclusion that it becomes empty during brief exposures to $+g$.

The emphasis has shifted to a consideration of alterations on the arterial side. The distance from the aortic valve to the base of the brain is approximately 31 cm. To lift a column of blood this high a pressure of 25 mm Hg. is required. If 5g are acting on this column, then the pressure needed increases to 125 mm Hg. Continuance of moderate g beyond 5 seconds may result in a decrease of symptoms. It would appear that the fall in pressure in the carotid artery stimulates the carotid sinus with resultant reflex vasoconstriction. This reflex has a latent period of approximately 10 seconds. It is only after this period that the circulation has an opportunity to re-establish itself. It is probable that if the pressor reflex could react quickly enough, blackout would occur at a higher average level than $+5g$. A system of g-protection can be based on this compensatory phenomenon if time permits. If a pilot will subject himself to 3g for 10 seconds before making a tighter turn, he will have stimulated the pressor reflex and his tendency to blackout with a larger force will be considerably reduced.

The early occurrence of visual disturbances, namely the dimming, tubular vision and blackout, is ascribed to the normal intraocular pressure of approximately 20 mm Hg. Any reduction of blood pressure in the vessels of the head usually reflects itself in visual symptoms because the central artery of the retina is already at a disadvantage of approximately 20 mm Hg.

3. Prophylaxis. Prophylactic measures are directed toward several objectives:

a. Increase blood pressure before the onset of the force.

b. Permit forces to act transverse to and not along the long axis of columns of blood.

c. Increase the abdomino-thoracic gradient of pressure.

d. Prevent pooling of blood in the lower parts of the body.

These objectives may be attained with measures concerning personnel and materiel.

Personnel: Anticipation, apprehension, and tensing of muscles are probably effective in increasing blood pressure. Crouching, grunting, yelling, and other modifications of the Valsalva maneuver are effective in maintaining an abdomino-thoracic gradient of pressure which presumably augments the flow of blood from viscera to the thorax. Crouching also puts long vessels transverse to the applied force. Eating before flight and maintenance of physical fitness are apparently effective through several mechanisms.

Materiel: Building cockpits so as to reduce the effect of g has limited value, and most of the construction plans available are not easily adaptable to the deep cockpit and the high gunsight of the American tactical airplane. High rudder bars have been used by the British with variable results. Horizontal seats (pilot prone) and automatic tilting seats have been considered but found impractical. Diving flaps help the pilot by reducing speed in the pull out. Limited elevators have practical disadvantages.

Anti-blackout or anti-g suits have been of three types: elastic, hydrostatic, and pneumatic. Currently, the pneumatic, in the form of the AAF type G-3 suit, is the one shown to be of greatest value. It weighs about 2 lb., can be folded to fit into a small bag, can be quickly put on or taken off, and may be left in the plane or worn during alerts. The source of pressure is the positive side of the vacuum instrument pump designed to keep the rotors of the flight instruments running by suction. The pressure supplied to the suit in accordance with the amount of force applied occurs at a rate between 0.5 and 1.0 lb. per g by a valve (G-2) which is entirely mechanical. On the centrifuge the suit increases the blackout threshold by 1g to 1.5g. In service tests performed on the alert pilot, as opposed to the relaxed subject in the centrifuge, the protection is sufficient to virtually eliminate dimming of vision even at levels up to +8g briefly applied. The precise way in which the suit works is not proven although it probably helps to

prevent pooling of blood, maintains an abdomino-thoracic gradient of pressure, and maintains the diaphragm at about its normal level.

Negative acceleration.

1. Subjectively, negative acceleration is accompanied by a feeling of congestion of the head and face, throbbing pain in the head, and above —4.5 g, by redout. Objectively, there may be facial and conjunctival congestion, increased pulse and respiratory rate, increased intra-carotid pressure, and mental confusion. For several hours after the force ceases to act, headache may persist.

2. Pathological physiology. *The opposite of what occurs with positive acceleration occurs under these circumstances.* Blood is driven to and retained in the upper part of the body raising the intracarotid and likely the intracranial pressure.

3. Prophylaxis. Avoidance of maneuvers involving large negative forces is the only preventive at present available.

Angular acceleration

Angular acceleration occurs as a result of change in direction and change in speed. It is the dominant type of acceleration seen in the spin of certain types of aircraft. It is more common for the *gyrogenic* rather than the *gravigenic* effects to dominate in this type of acceleration, although the latter are of considerable importance in preventing escape from aircraft which are spinning out of control.

Summary

It is to be noted that in the foregoing discussion, types of acceleration have been classified and designated as though aeronautical maneuvers could be sharply divided as involving each type. The truth of the matter is that in most aerobatics and tactical maneuvers, all types of acceleration and deceleration occur, although one type may predominate in one particular maneuver.

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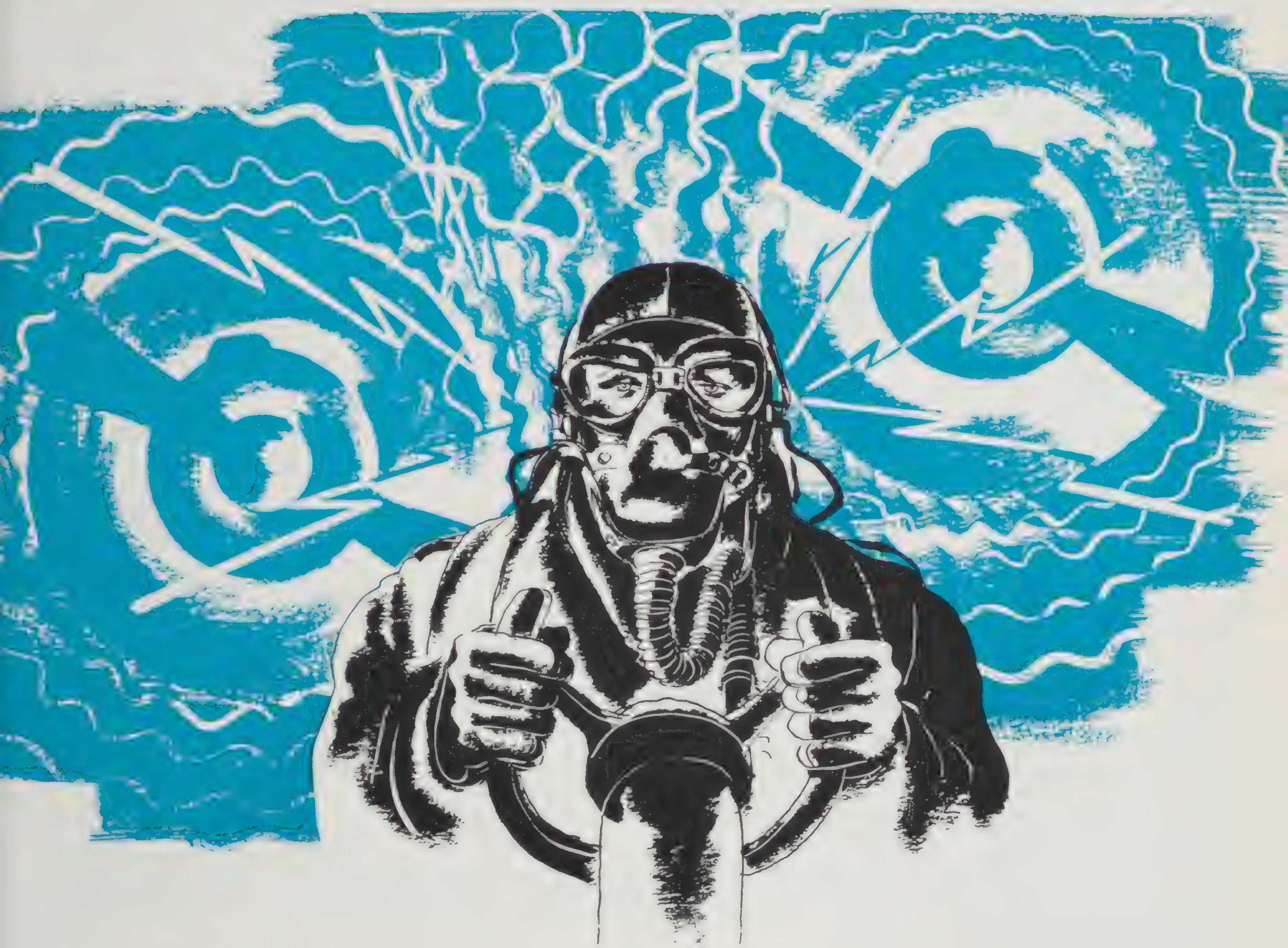
EFFECTS OF NOISE



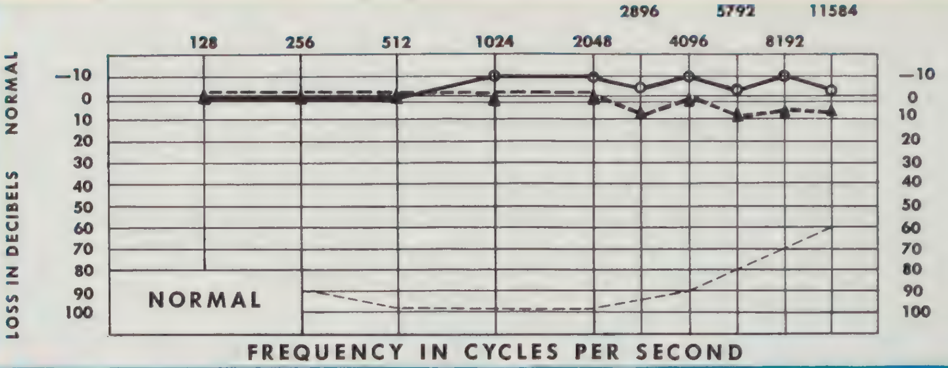
Much controversy exists regarding the degree and permanence of impaired hearing which may occur as a result of exposure to noise in aircraft. A few authorities have stated unequivocally that pilots will suffer severe hearing disability after a time. Some report high percentages of normal hearing among flying personnel. Others emphasize the development of an auditory defect localized around 4906 cps.

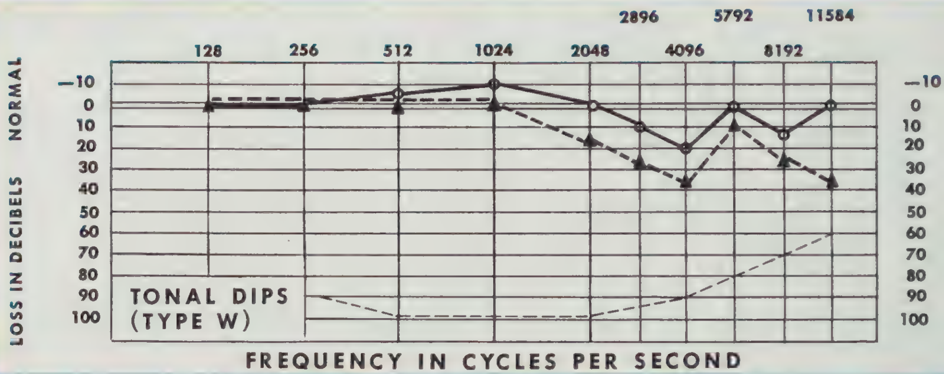
The "normal" audiogram

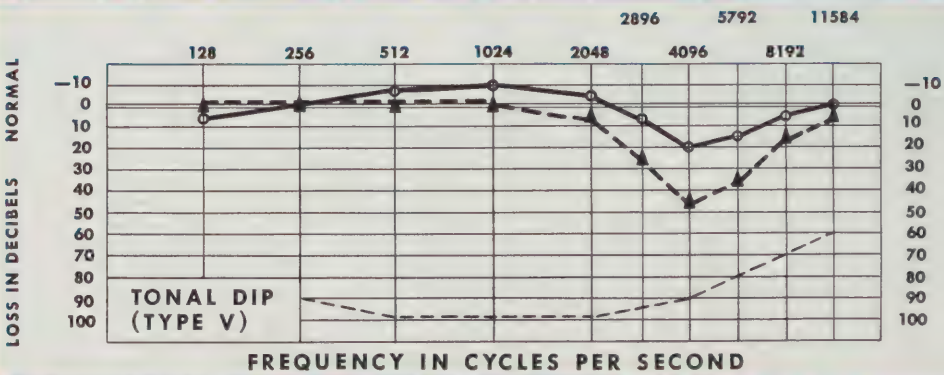
Hearing defects in the general population have been pointed out in numerous reports. From these reports one is made aware of the fact that so-called "normal" hearing must not be expected among all of the young men who are chosen for aeronautical training despite careful initial screening by the whispered voice tests. Various types of audiograms as obtained from aviation cadet applicants with 15/15 hearing for whispered voice are demonstrated in the accompanying figure. Defects of the types shown are so common that they should be anticipated in approximately 2 out of every 3 cases examined with the audiometer. Tonal dips of 15 db or more may occur in as many as 25% of ears of cadets, prior to any exposure to airplane noise.

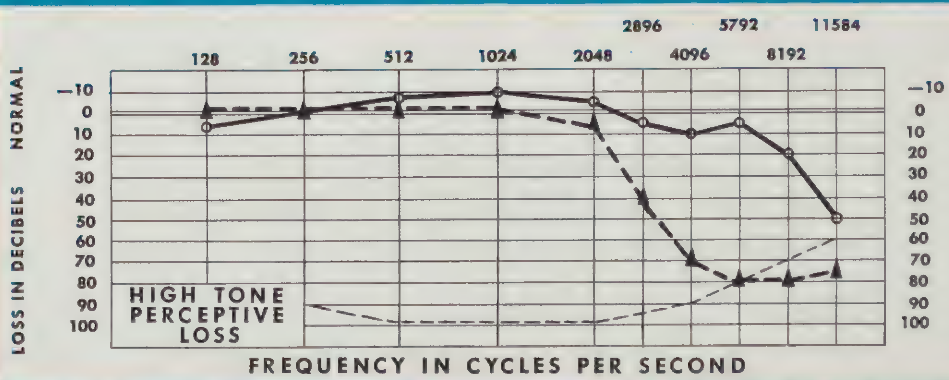
High tone ("perceptive") losses occur in 20% of "normal" ears. These losses do not interfere with the hearing of the whispered or spoken voice, since they are above the speech range and are consequently undiscovered except on audiometry.

SAMPLE AUDIOGRAMS SHOWING TYPES AND GRADES OF HEARING LOSSES









O = RIGHT

▲ = LEFT

Aircraft noise

Aircraft noises are a contributing cause of auditory fatigue. Levels and spectra of noise found in aircraft vary depending upon such factors as number of engines, amount of insulation, presence of poorly fitting canopies and ventilators, etc. Most combat aircraft will show noise levels as high as 110 db to 125 db with a typical spectrum of intense noise in the low frequencies and a smaller intensity at the high frequencies.

The cockpit of a plane in flight is essentially a closed chamber, separated from the outside air only by a thin wall of the fuselage, or "skin." Since the principal sources of noise (engine, propeller, and slipstream) are outside this chamber, it is evident that, in order to affect the occupants, the outside noise must in some way penetrate the walls, and that the "transparency" of the walls to sound (transmission) will be a large factor in determining sound levels within. Sound which has gained access to the interior bounces back and forth between the walls by reflections until its energy is dissipated by encountering sound absorbing material which may be present in its path. Meanwhile more sound is coming in through the walls, which adds to the first, and so on, building up the level of sound in the plane until the rate of loss by absorption equals the rate of gain through the walls, and the system is in dynamic equilibrium for the particular flight conditions.

In any airplane, if little sound energy comes through the walls, then little soundproofing is required to keep the noise level low; and conversely, if the windows of the plane are wide open so that sound can enter freely, then all the soundproofing possible will not prevent the noise inside from being about the same as that outside. These facts are of prime importance in understanding why the noise level finally achieved depends upon *both* factors (absorption and transmission), and why any effective soundproofing must be directed both toward diminishing the sound entering through walls and openings and toward increasing the rate of its absorption after it has entered.

TABLE OF NOISE LEVELS

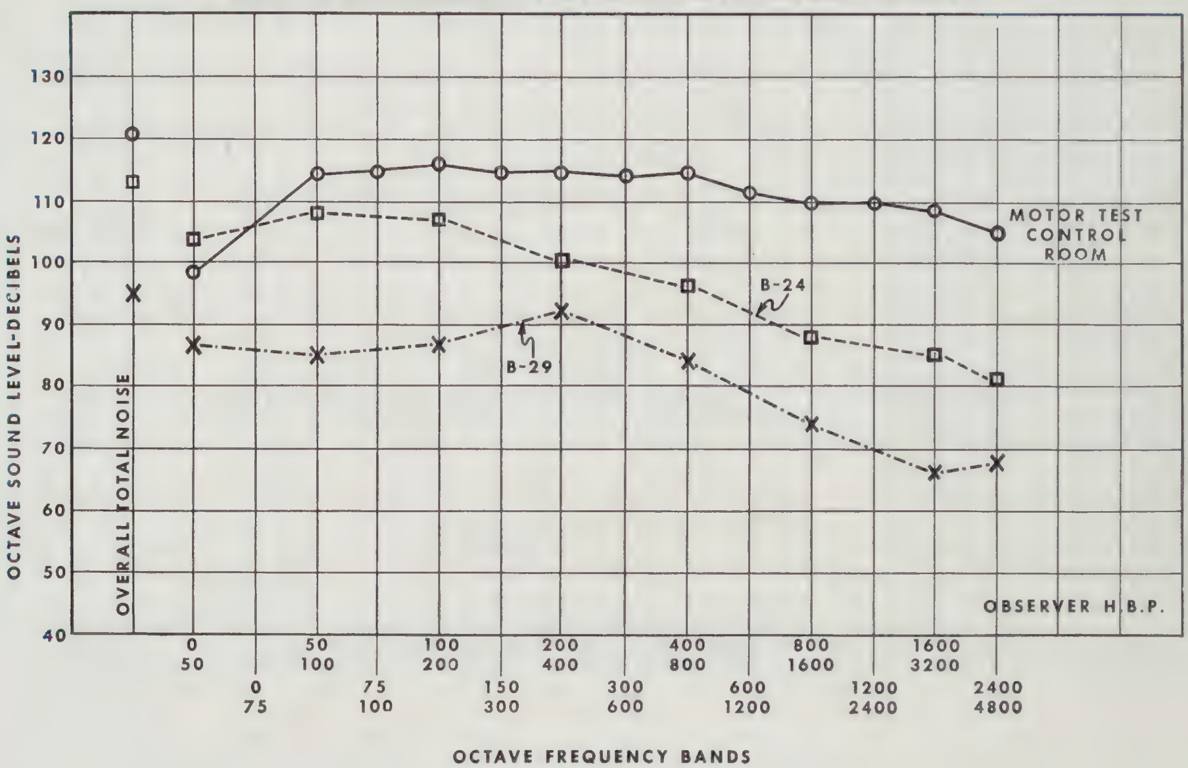
	LEVEL IN DECIBELS
B-24D Aircraft (240 M.P.H.)	126
Motor Test Block (Control Room)	122
B-25H Aircraft (180 M.P.H.)	119
Helicopter XR-6 (40 M.P.H.)	114
B-24D Aircraft (170 M.P.H.)	112
B-29 Aircraft (180 M.P.H.)	95
Riveter (heard from street)	85
Ordinary Conversation (5 ft.)	70
Noisy Office	60
Typewriter in quiet office	40
Turning page of newspaper	30
Whispered Conversation (5 ft.)	25
Threshold of Hearing	0

Aircraft noise is made up of at least three major constituents:

1. Slipstream (aerodynamic noise; random noise).
2. Propeller noise (line spectrum).
3. Engine vibration, exhaust, etc. (adventitious noise).

The *slipstream* noise results simply from the turbulence caused by the passage of the aircraft through the air and is directly related to the number and degree of irregularities and openings presented by the external surface of the aircraft, and to the speed of the plane. It may be described best as being

SAMPLE MEASUREMENTS OF MILITARY AIRCRAFT NOISE



similar to random or "white" noise (like white light), and consists of approximately equal components of all the frequencies in the audible auditory spectrum from the lowest to the highest. When heard alone it has a "hissing" character. A striking example of this type of noise is afforded by the glider in flight where noise levels of about 115 db have been recorded.

The *propeller* noise is made up especially of the low frequencies and is essentially a 40-60 cycle hum with overtones. More accurately, the fundamental tone equals the frequency at which the propeller tip passes the fuselage, and the overtones are multiples of this fundamental. Thus, a 2-bladed propeller turning at 1500 rpm would pass a given point in the air 3000 times per minute, or 50 times per second and consequently would produce a fundamental tone of 50 cps. The harmonics would then be 100, 200, 300 cps, etc.

Adventitious noises include a variety of noises such as hums, vibrations and rattles within and without the cabin. The importance of these is well illustrated in the case of the B-29 in which the ordinary airplane noises have been so effectively reduced that the hums due to the generators and air-circulating fans are very prominent. Exhaust noises are of importance only when certain types of exhaust manifolds are used, and in most aircraft may be ignored.

A combination of these various noises makes up the typical aircraft noise spectrum. For the reasons discussed above, it is noteworthy that:

1. The most intense noise is found in the low frequency octaves, and
2. Airplanes differ appreciably in noise levels due largely to differences in power of the engines and to differences in soundproofing and air leaks.

Radio noise

A study of aircraft noise would not be complete unless some consideration were given to the airplane radio which provides still another source of fatiguing sounds for personnel wearing headphones. These may be listed as:

1. Atmospheric static.
2. Thermal and tube noise in the receiver.
3. Pickup from electrical equipment (electric hum).
4. Beam.

Atmospheric static and *tube noise* consist principally of the "white" type of noise mentioned previously, containing a continuous band of all the frequencies. Atmospheric static, unlike tube noise, is discontinuous in time and intensity, thus creating the random bursts and crashes.

Electric hums of various frequencies may be introduced as a result of ignition sparks and inverters.

The beam, which is a 1020 cps tone, stimulates one of the most sensitive portions of the cochlea. It is in this region that it is particularly easy to fatigue the ear with relatively low intensities and short durations of sound.

Auditory fatigue

Cause. It is generally agreed that noise intensities of 90 db or more (particularly the frequencies above 500 cps), if continued over a long period of time, will fatigue most ears. The majority of military aircraft have cockpit noise levels which exceed this value. Actual measurements in aircraft have shown noises varying from the relatively quiet B-17 and B-29 with levels of approximately 95 to 110 db to the B-25 and BT-13 which may show overall levels of 120 to 125 db. Thus the problem of noise is not so serious in the larger aircraft which can afford the luxury of a great deal of sound insulation. However, in the smaller combat and training aircraft, noise levels are high enough to cause temporary hearing losses which interfere with the understanding of the spoken voice *during* a flight and for a variable period *after* the completion of a flight.

Airplane noise can regularly produce temporary hearing loss (auditory fatigue) in all persons. Susceptibility varies so that the temporary loss occurs more readily in some persons than others. The weight of evidence indicates that *temporary* hearing losses always occur at or above the fatiguing tones so that if an aircraft has a predominance of low tones (40 to 60 cps), losses will occur in the lower and middle frequencies; if the greatest intensity of noise is in the region of 256 to 512 cps, the greatest losses may be expected to occur in the middle and higher frequencies. In contrast, *permanent* losses from exposure to aircraft noise tend to occur in the region at 2896, 4096 and 5792 cps in susceptible subjects. No satisfactory explanation is available for this peculiar vulnerability to acoustic trauma of the 4096 cps region of the cochlea.

The above observations can be directly applied to temporary hearing losses resulting from "riding the beam." Since the beam is a pure tone of 1020 cps, instructors and pilots who have been exposed for long periods may show marked losses at and above the fatiguing tone, thus involving the frequencies 1024, 2048, 2896, and 4096 cps. Recovery of the lower tones is very rapid. Losses in the region of 4096 cps,

which may have been present prior to exposure, will of course persist. In susceptible ears these V-notches may broaden out to encroach on the speech range, or high tone losses may develop above the speech range.

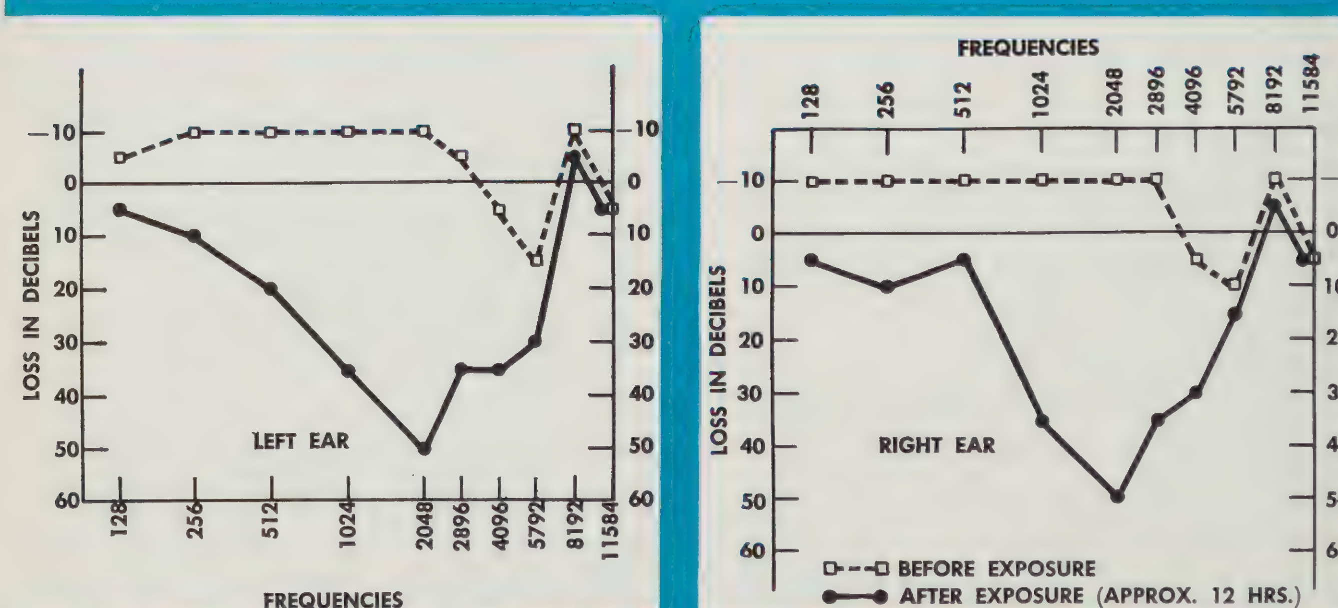
Little information is available in regard to the effect of gunfire upon the occupants of aircraft in flight. Since the fighter pilot and gunner are protected from the gun blast by the fuselage and slipstream, it would be anticipated that this source of noise would play only a minor role in the production of auditory trauma. This has been shown to be the case in a controlled study of aircraft gunners in which the air specialists (gunnery instructors in aircraft) who had been exposed to gunfire over long periods, showed only slightly more hearing loss than was found among a similar group of students who had little or no exposure to gunfire in aircraft.

Temporary Auditory Fatigue. It has been clearly demonstrated that hearing losses can occur as a result of exposure to noises in aircraft, but these are *temporary losses* which occur in the largest percentage of men in combat training and from which recovery will occur during short rest periods. These temporary losses, when due to aircraft noise and the beam, tend to involve the frequencies 1024 to 5792 cps. Within 24 to 48 hours following exposure there is almost complete recovery for all of the low tones, while in the more vulnerable 2896 to 5792 cps region, recovery of hearing losses may be delayed.

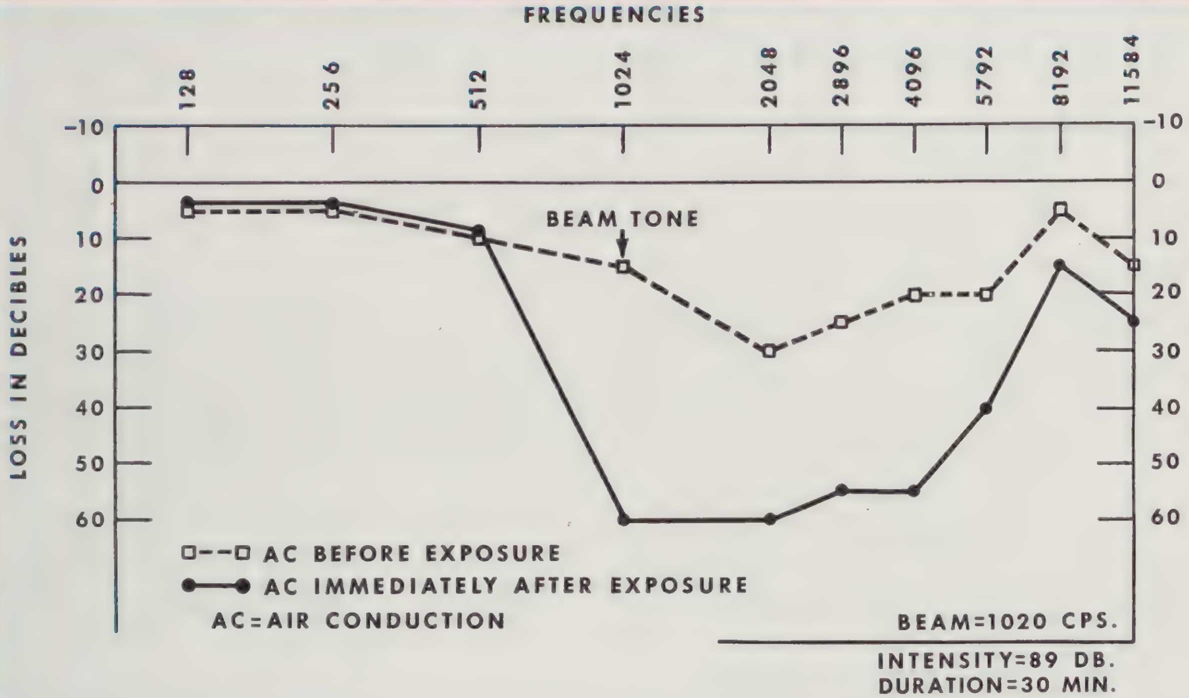
Recovery is variable depending upon the intensity and duration of the fatiguing stimulus and the susceptibility of the subject. Most subjects recover in a period of minutes or hours while others require weeks for complete recovery. A good rule of thumb is that the recovery time is equal to the square of the noise exposure time.

Permanent Loss of Hearing. As a direct result of exposure to noise in aircraft, some permanent loss of hearing may be expected to occur in a small percentage of susceptible subjects, particularly if they will not take adequate measures to protect their hearing. However, it is anticipated that in the AAF as a whole the findings may be very much the same as found in a group of student pilots who were observed during their first 210 hours of pilot training. In this group a small number of ears showed increased V-notching and a high tone loss, but not a single ear showed any severe or unusual audiographic change as a direct result of exposure to aircraft noise. In no case was there a loss which interfered with the hearing of speech.

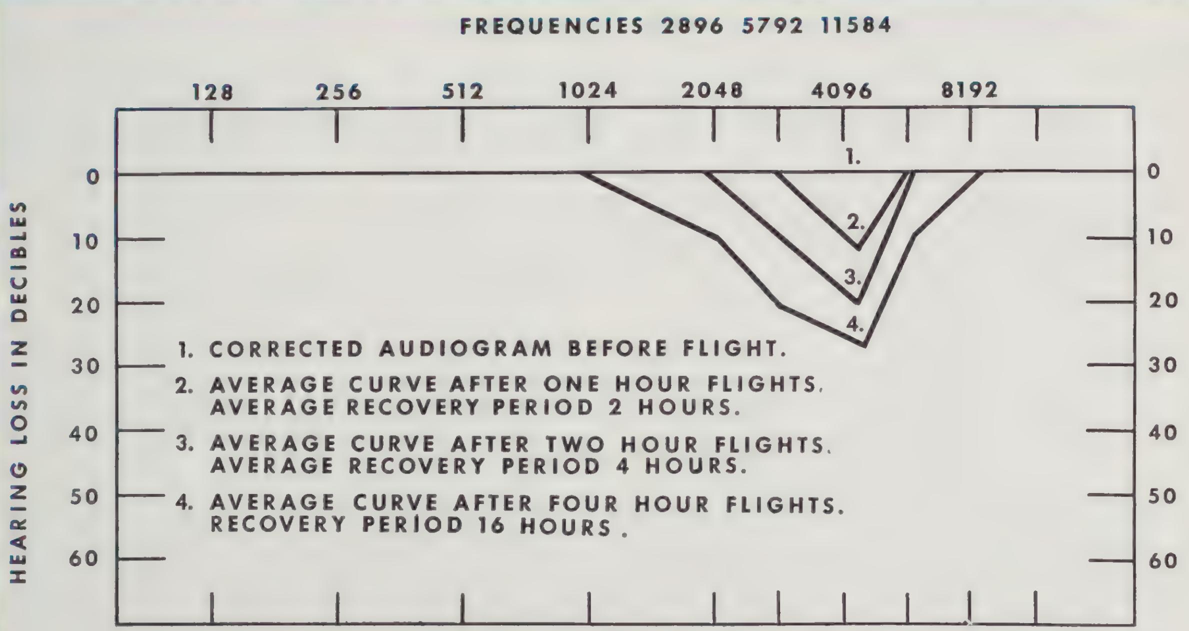
AUDIOGRAM SHOWING HEARING LOSSES RESULTING FROM EXPOSURE TO AIRCRAFT NOISE



AUDIOGRAM SHOWING THE EFFECT OF EXPOSURE TO THE BEAM



EFFECT OF AIRCRAFT NOISE AND RECOVERY PERIODS



If the subject is susceptible to acoustic trauma and the exposure to intense aircraft noise is prolonged without intervening periods of rest, permanent hearing losses will occur. These tend to be limited at first to the 4096 cps region of the cochlea, but if exposure continues, there will be a progressive spread to involve the lower and higher frequencies. The important speech frequencies (512 to 2048 cps) may be encroached upon and become seriously involved so that there is interference with the hearing of the conversational voice.

Prophylaxis. Recent developments in aircraft design and improvement in radio equipment may reduce the ambient noise to some extent but in the main, protection of hearing will develop upon the pilot himself.

The pilot or crew member has several choices:

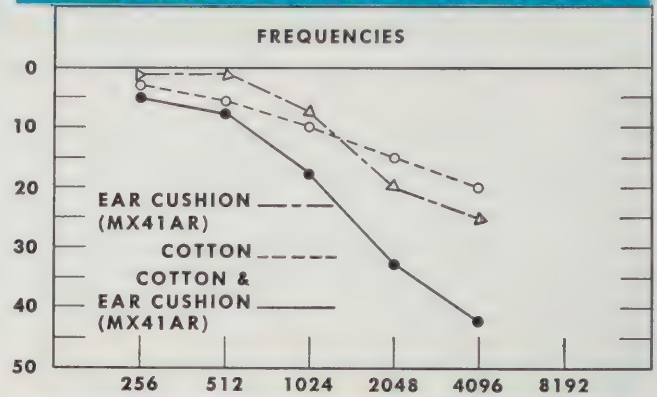
1. Headphones alone.
2. A combination of cotton plugs and headphones.
3. Molded or wax ear protectors.

Certain types of earcups (notably the old MC-162 type) provide a poor seal over the ear and therefore filter out only a small amount of the low and a somewhat greater amount of the high frequency noise. Newer designs (such as the MX41/AR and M301) are much better. Earcups alone provide no protection against noises such as the random bursts and crashes of atmospheric static or the intense unexpected variations in the beam tone arising within the headphones themselves.

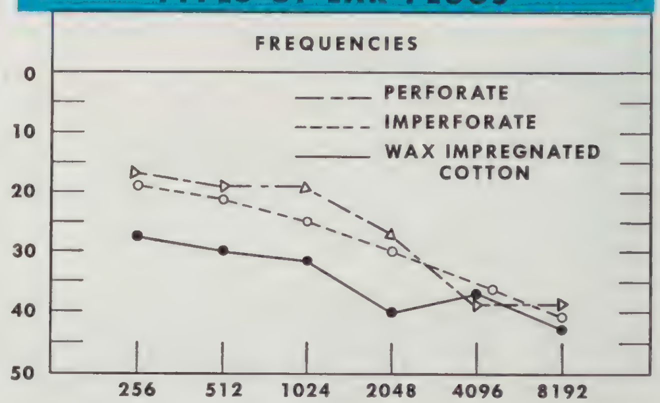
The simplest and readiest means that the pilot has available for ear protection is the combination of cotton plugs in the ear canals covered over by well fitting headphones. Even in the earliest days of aviation, conscientious pilots wore cotton in their auditory canals for protection against the intense noises of the old short stacked aircraft. More recently, this very laudable habit has fallen into disuse among the younger students and instructors.

The amount of attenuation (protection) afforded by cotton plugs, ear cushions, and a combination of these two is shown in the figure. Cotton or earcups alone provide only a small degree of attenuation in the region of the low tones (where aircraft noise is most intense) while fairly good protection is provided by each against the high tones. However, the combination of cotton plugs and well-fitting ear cushions, such as the Type MX41/AR, will provide satisfactory ear protection for the average airman. More ear protection is offered by the non-perforated molded or self-molding ear protectors, but it is advised that these *not* be used routinely by aircrew

AUDIOMETRIC CURVES SHOWING PROTECTION AFFORDED BY COTTON EAR PLUGS AND CUSHIONS



COMPARISON OF HEARING PROTECTION AFFORDED BY VARIOUS TYPES OF EAR PLUGS



members, because of the occurrence of aero-otitis externa (see below).

For general use by non-flying AAF personnel exposed to loud noise, there are available molded *imperforate* ear plugs (NDRC V-51R Ear Wardens, MSA Ear Defenders), molded *perforate* ear protectors (Sepco and SMR Ear Protectors), and wax impregnated gauze ear stoppers (Flents Anti-Noise Ear Stopples, Olygo Noise Absorbers), all of which offer excellent protection against noise. In field tests to determine wearability, durability, etc., it appears that a simple and easily cared for molded ear plug is preferred, particularly if it can be worn under headphones with a minimum of discomfort and if it provides good attenuation and high fidelity.

An objection to the use of ear plugs which is frequently presented is that a device which adequately attenuates noise will also reduce the intensity of speech reception. Actually when ear protection is used in the high ambient noise levels found around

motor blocks, crash boats, or aircraft, there is no interference with the hearing of speech. In fact, under certain conditions, there may actually be some slight improvement in hearing. This is accomplished by the operation of several factors. The ear protector reduces the intensity of both noise and speech to a more comfortable level and then the volume of the speech or of the radio may be increased without an accompanying rise in the ambient noise intensity. Even under certain ground conditions where noise levels exceed 75 db it has been shown that ear plugs do not interfere with the hearing of speech.

Aero-otitis externa

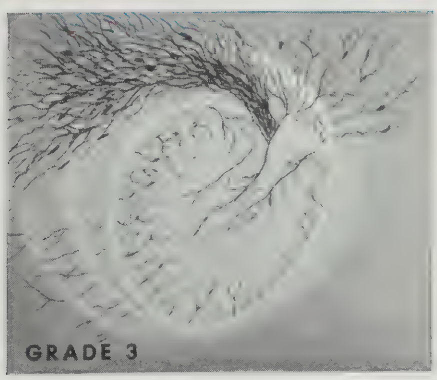
It is advised that non-perforated molded, imperfectly perforated, or wax plugs *not* be used by flyers. It has been conclusively demonstrated that any ear plug which completely seals the external auditory canal will cause severe vascular damage to the soft tissues of that canal during descent from medium and high altitudes (aero-otitis externa). As a result of the development of negative pressure in the ear canal, petechiae, ecchymoses, or frank hemorrhagic bullae may occur on the canal wall and tympanic membrane following use of non-perforated plugs.

AERO-OTITIS EXTERNA

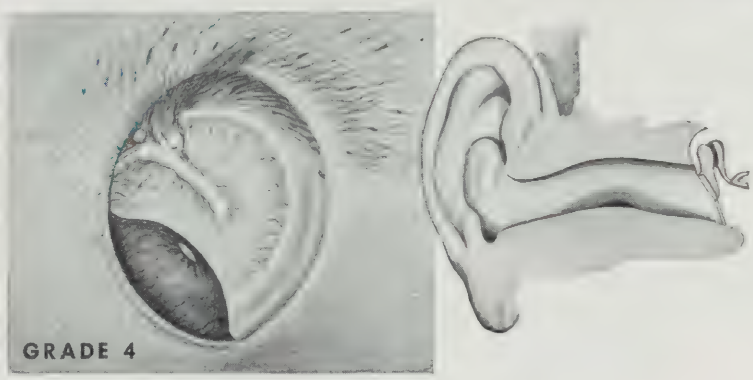
Semi-diagrammatic drawings showing various grades of vascular damage due to the use of non-perforated or inadequately perforated ear plugs during flight in aircraft.

GRADE 1

GRADE 2



GRADE 3



GRADE 4

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EFFECTS OF PARACHUTE DESCENT

The critical altitude at which parachute escape becomes complicated is thought to be in the vicinity of 26,000 to 28,000 feet. At and below this altitude a number of successful escapes have been made without emergency oxygen equipment, although not without injuries from opening shock of the parachute. At higher altitudes all the factors concerned with safe descent become more important.

Aircraft disabled but under some control

When the aircraft is disabled above 30,000 feet but is under some control, it appears that the better choice is to bring the aircraft to a lower altitude before bail-out is attempted. In some high speed fighter aircraft the rate of descent is limited by the disintegrating effects of compressibility. If the oxygen supply of the plane has been damaged, the H-2 emergency oxygen cylinder (see Section 8-1) will enable the flyer to come down with the aircraft to a safe level.

Aircraft out of control

Centrifugal forces must be taken into account when an attempt is made to "ride down" an aircraft that is out of control. These forces may be sufficient to pin a flyer in his seat or make crawling to an escape hatch or donning a parachute impossible. Tests on the human centrifuge indicate that at 3g the average pilot is unable to lift himself out of the cockpit. Even at 2g this becomes an extremely difficult task. At 2 to 3g donning a parachute harness or even attaching a chest parachute becomes a major task that requires 2 to 4 times the normal length of time. These are the finding in experiments on a centrifuge where forces are at right angles to the long axis of the body and are continuous. In an airplane where the direction of force may be changing and may be directed toward the sides, ceiling, or floor of the cabin the increased difficulty can be imagined. Tests on the centifuge show that a force of 3g is about the maximum against which a man can crawl when provided with hand and foot holds to pull against. The limbs, however, may be moved fairly easily.

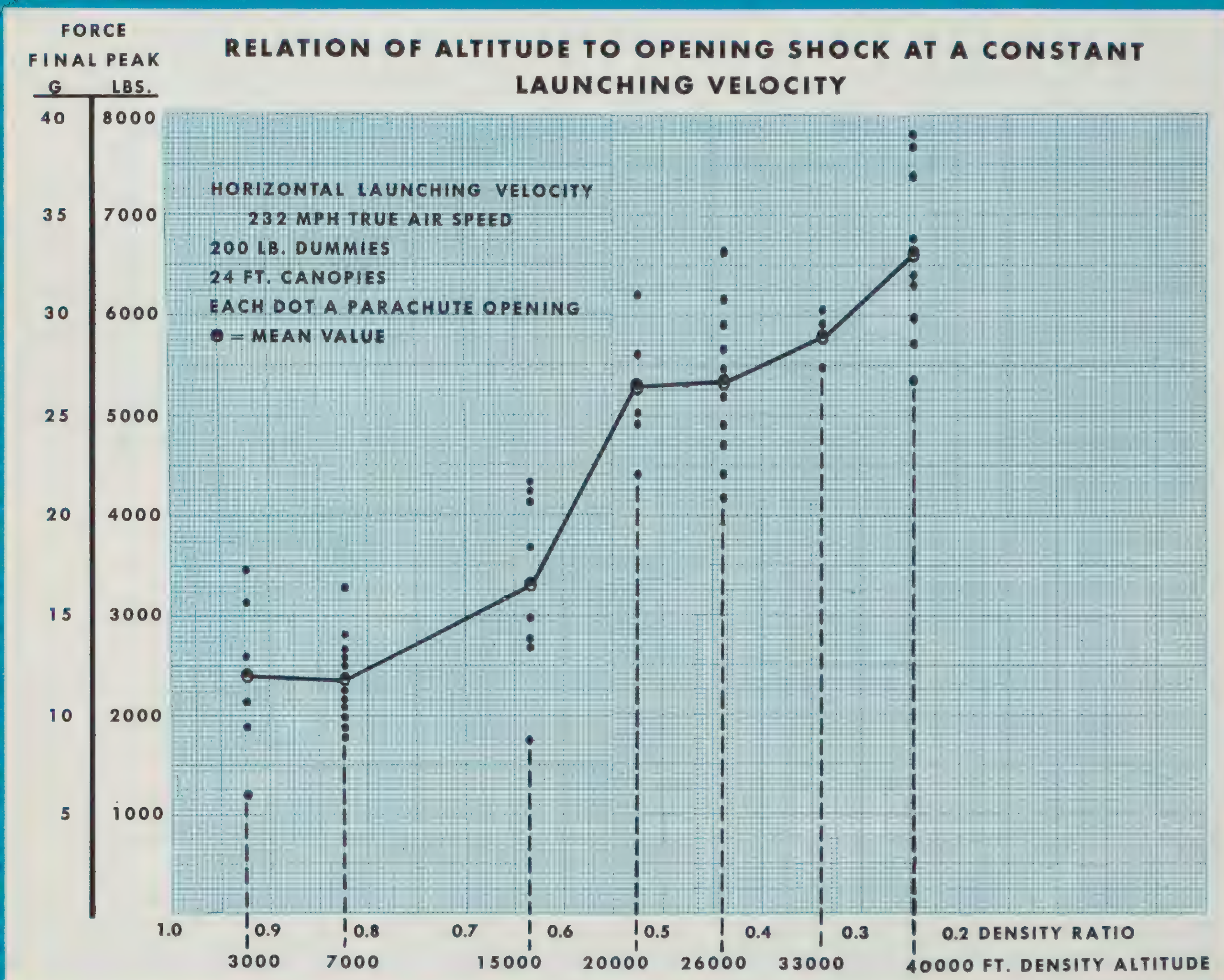
Need for oxygen during escape

In bomber aircraft the flyer may have to traverse some distance before reaching an escape opening. This, plus effort in opening hatches, will require an oxygen supply for any escape much above 20,000 feet, depending on the time and exertion involved. In bombers this will necessitate changing to a walk-around cylinder for maximum safety at altitudes between 20,000 and 28,000 feet. Above 28,000 it is doubtful that a crewman could escape at all without oxygen where any distance or effort was involved. If the aircraft is out of control, even low centrifugal force will make change to a walk-around cylinder very difficult if not impossible. These considerations emphasize the need for a source of oxygen on the man and attached to his mask as provided by the H-2 emergency cylinder, at least above 30,000 feet and probably at lower altitudes.

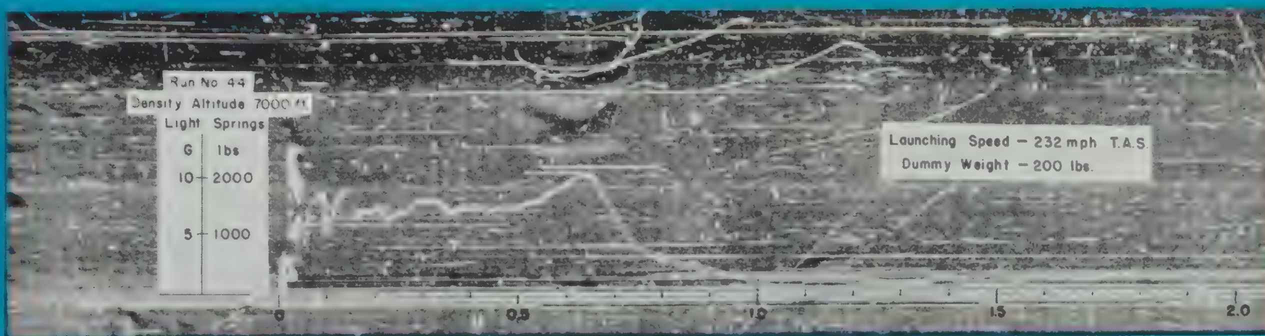
Opening shock of parachute

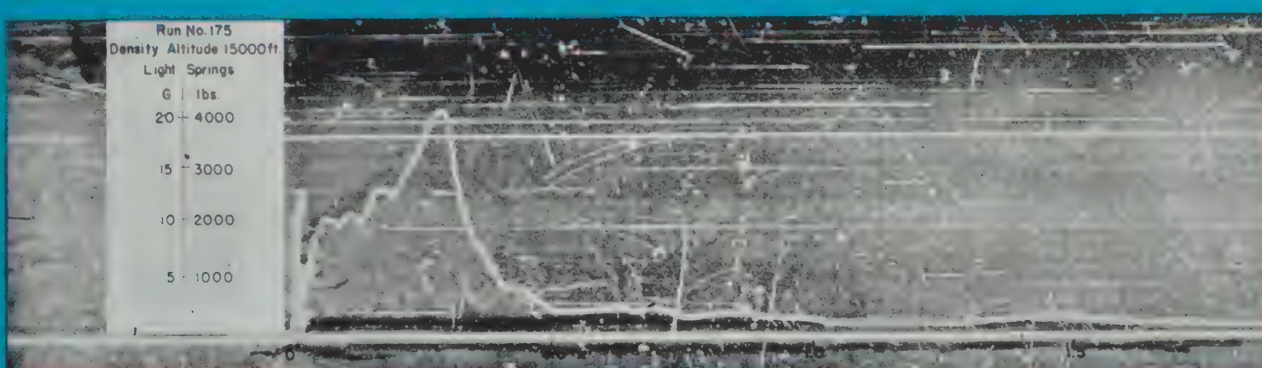
Experience in several parachute descents where the parachute was opened above 30,000 feet led to the suspicion that forces of opening were greater than those at lower altitudes. Drop tests with dummies have been made which confirm this suspicion. At 10,000 feet and up to 20,000 feet the opening shock on a 200 lb. dummy wearing a 24-foot canopy at free-fall rates is about 10g. At 40,000 feet under the same conditions the force is about 33g. These forces last for a very short time and are in the nature of an impact. There is some variance in the force in different drops. Some drops have been made where the force was sufficient to tear the parachute webbing. Increases in speed at high altitude have more effect in increasing the opening shock than equivalent increases at lower altitudes. Further experiments are being made to obtain more data on effects of rate of fall, weight of dummy, size of canopy, and other factors that may be involved.

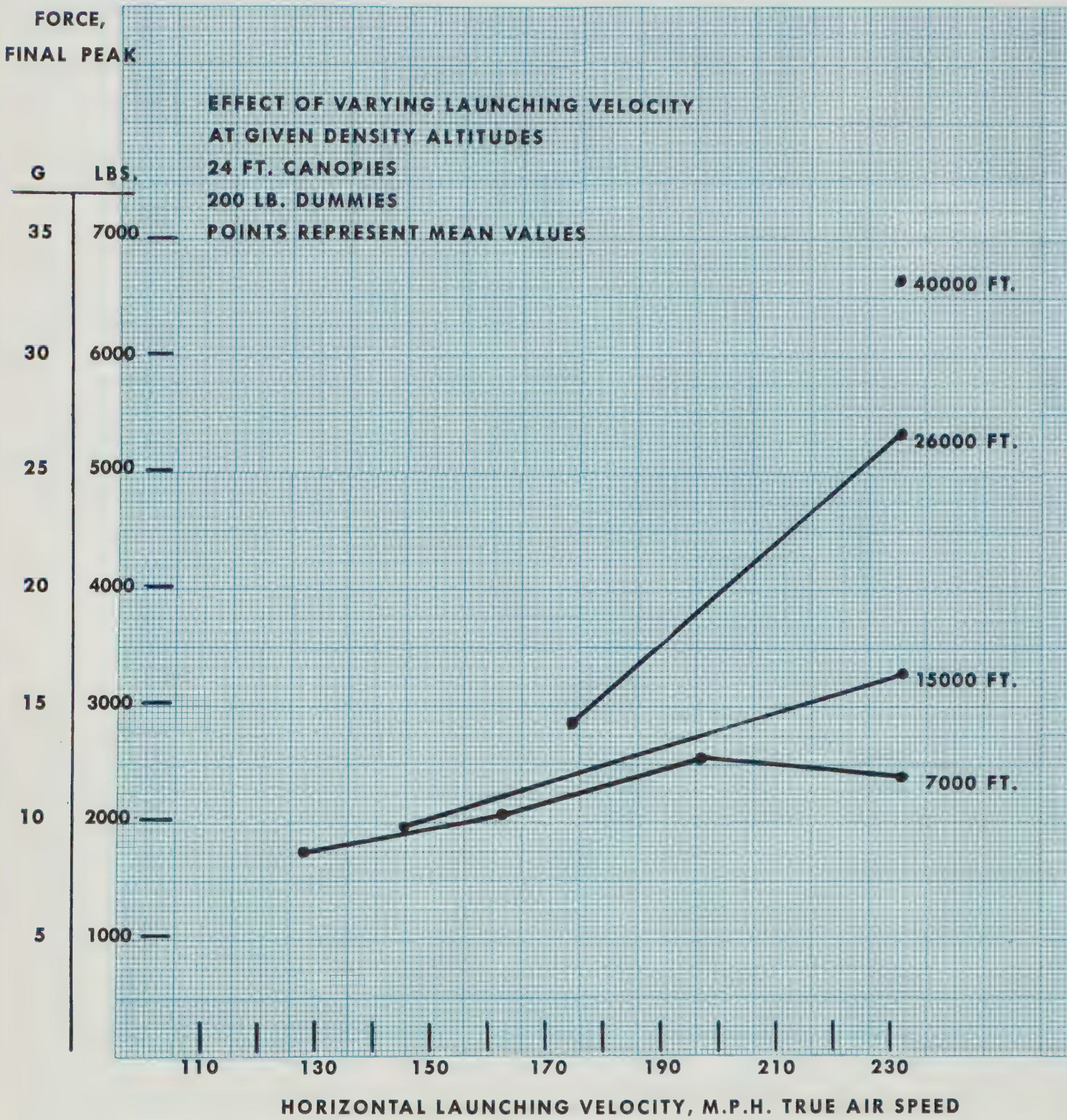
At present it is safe to say that there is a definite hazard to personnel from the force of a parachute opening above 20,000 and that the hazard is greater as altitude is increased.



RECORDS OF OPENING SHOCK OF PARACHUTE AT VARIOUS ALTITUDES





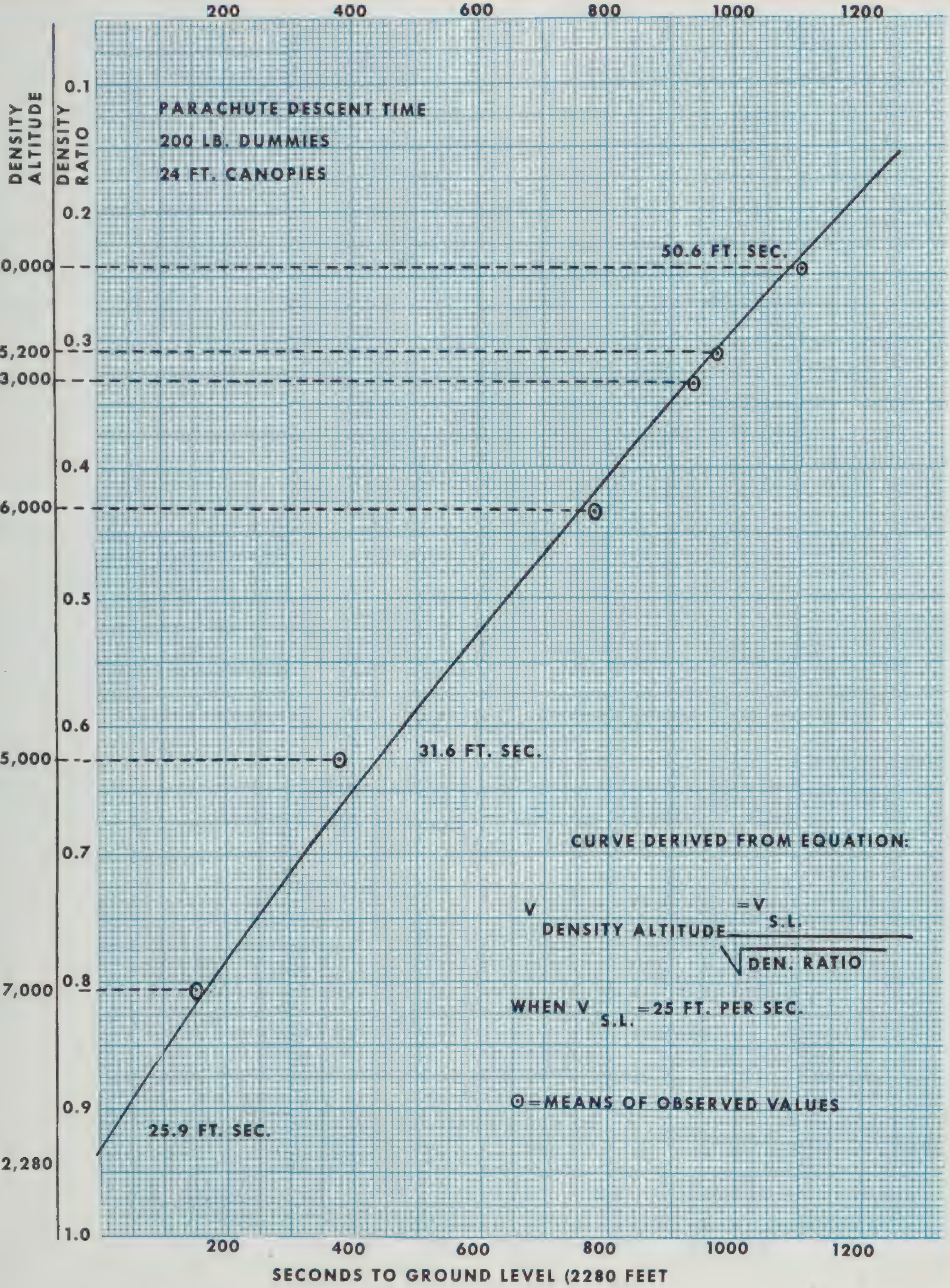


Frostbite during parachute descent

Records of a few open parachute descents from above 30,000 feet have shown that frostbite of exposed areas may occur. The rate of freezing during free fall and during open parachute descent, and the human limitations are not known, but the hazard warrants every effort to wear goggles, helmet, oxygen mask and gloves, and if possible to free-fall as far as possible through regions of extreme cold.

Open parachute descent

Probably the region below which open parachute descent may be made safely without oxygen is around 28,000 to 30,000 feet. Here again there are a few actual experiences upon which to base conclusions. Experiments in the low pressure chamber show that descents may be made safely from 30,000


PARACHUTE DESCENT TIME
200 LB. DUMMIES
24 FT. CANOPIES
DENSITY ALTITUDE
DENSITY RATIO
200
400
600
800
1000
1200
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
40,000
35,200
33,000
26,000
15,000
7,000
2,280
50.6 FT. SEC.
31.6 FT. SEC.
25.9 FT. SEC.
CURVE DERIVED FROM EQUATION:
V DENSITY ALTITUDE = V S.L. / √DEN. RATIO
WHEN V S.L. = 25 FT. PER SEC.
⊙=MEANS OF OBSERVED VALUES
SECONDS TO GROUND LEVEL (2280 FEET

feet without oxygen, but these experiments are not complicated by fear, severe exertion before escape, severe initial anoxia, or low temperature. It is to be expected that actual conditions would be more severe than those in the experiments. In the European Theater of Operations a number of escapes have been made in the region of 28,000 feet without an emergency supply of oxygen. The human limitation here would probably be variable, as have been the experiences in duration of anoxia and unconsciousness that have resulted in death in aircraft. It is recommended that the H-2 emergency oxygen equipment be worn above 30,000 feet routinely. Below this altitude present indications in the 8th Air Force are that the hazards do not seem severe enough to warrant routine use of this equipment in bomber aircraft. This policy is subject to revision.

Free-fall descents

In the low pressure chamber successful free-fall descents can be made from 40,000 feet without oxygen equipment if the breath is held. In actual practice this would be much harder to do because (1) breath could not be held as long following exertion entailed in escape; (2) excitement and fear would probably reduce breath holding; (3) it is probable that a man in a rapid tumbling or spinning movement would be unable to hold his breath very long.

The time of descent in a free-fall has not been accurately determined for all conditions. The time for Boynton's fatal jump was 2 min. 35 sec. from 42,000 feet. This was about 30 sec. shorter than the time calculated on the basis of records from lower altitudes. In Boynton's and in Starnes' free-fall there was evidence that the rate of fall varied during descent, probably due to the position of the body.

Another factor involved in free-fall is the venturi action of windblast across the free end of the oxygen mask hose. In wind tunnel tests this may cause a suction of as much as 1 in. Hg. In an actual fall, this pressure could not be constant because of the changing position of the body and the end of the hose. In the low pressure chamber at —15°C., 8 in. H_2O pressure applied constantly during a simulated descent from 42,000 feet using an H-2 emergency assembly caused a lowering of arterial saturation to as low as 63 per cent. The suction was startling to the subject but did not prevent him from breathing, nor did it cause loss of consciousness.

If a man becomes unconscious from anoxia in a free-fall from high altitude without oxygen, he may or may not regain consciousness in time to pull the ripcord. Experiments at ground level in which anoxia was produced by varying nitrogen-oxygen mixtures to simulate descent from 36,000 feet showed that all subjects did regain consciousness. The transfer of such data to actual conditions is a long one and does not convince most people that unconsciousness during free-fall should be voluntarily accepted. It seems to be the consensus that flyers would rather risk anoxia, cold, and opening shock than the possibility of not regaining consciousness in time to pull the ripcord. In the region above 30,000 feet a man without oxygen equipment would have little choice. The flyer must accept the fact that any procedure in this region without oxygen is extremely hazardous.

Free-fall is recommended in all circumstances at high altitude rather than open parachute descent, when the H-2 emergency assembly is worn. In consideration of the facts now known and experiences that have been gained in combat it is recommended that the H-2 emergency cylinder be worn on the body and connected to the oxygen mask in all fighter aircraft above 20,000 feet and in all bomber aircraft at least above 30,000 feet. The lower altitude for fighters is recommended because this cylinder is the only source of emergency oxygen.

Escape from aircraft at high speeds

Escape from aircraft at high speeds presents a potential hazard from injuries that might be caused by high velocity windblast. Here again little is known and the human tolerances are uncertain. Some experiences indicate that the force of the wind may be sufficient to damage the body. Evidence is difficult to collect because it is difficult in fatal cases to differentiate between injuries caused by striking some portion of the aircraft after escape, and injuries resulting from direct action of windblast upon the body.

Some pilots have described experiences in which it appeared that they were sucked out of the cockpit when the canopy was released. Bubble canopies have struck the head when released, which has led to instruction for pilots to crouch when the canopy is released.

Injuries seen with escape by parachute

In one study of 400 attempts at parachute escape, 50 resulted in fatalities. A distribution of the assigned causes of these deaths indicates that more than three-fourths of the fatalities resulted from three circumstances: the jump was made at too-low an altitude (47%), a crew member hit the aircraft

on bailing out (20%), or the parachute fouled on the aircraft (10%). Miscellaneous causes (22%) included failure to pull the rip cord, improper fitting of the harness, use of a single parachute by two persons, burning of the canopy, and drowning.

When consideration is given to the type of aircraft from which the bailout was made, the fatality rate varies (see chart) from less than 5% for jumps from twin-engine training planes to almost 25% for jumps from pursuit and single-engine training planes. No significant difference is shown in the percentages of non-fatal injuries resulting from jumps from various types of aircraft.

About 90% of those who suffered non-fatal injuries while making parachute jumps incurred these injuries on landing. Twenty percent of this group sustained fractures of one or more bones and an additional 24% suffered sprains of one or more joints. The fracture rate for personnel surviving jumps was 9.4%. Two-thirds of the fractures and sprains sustained were in the lower extremities.

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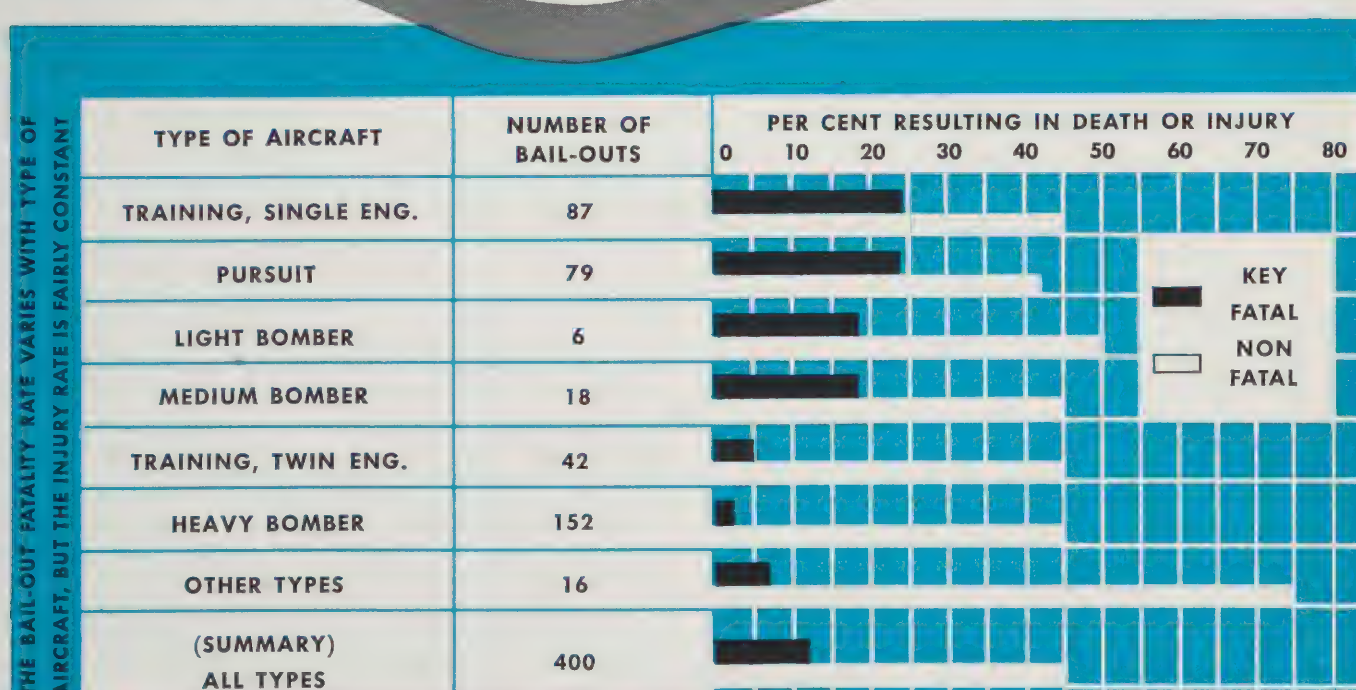
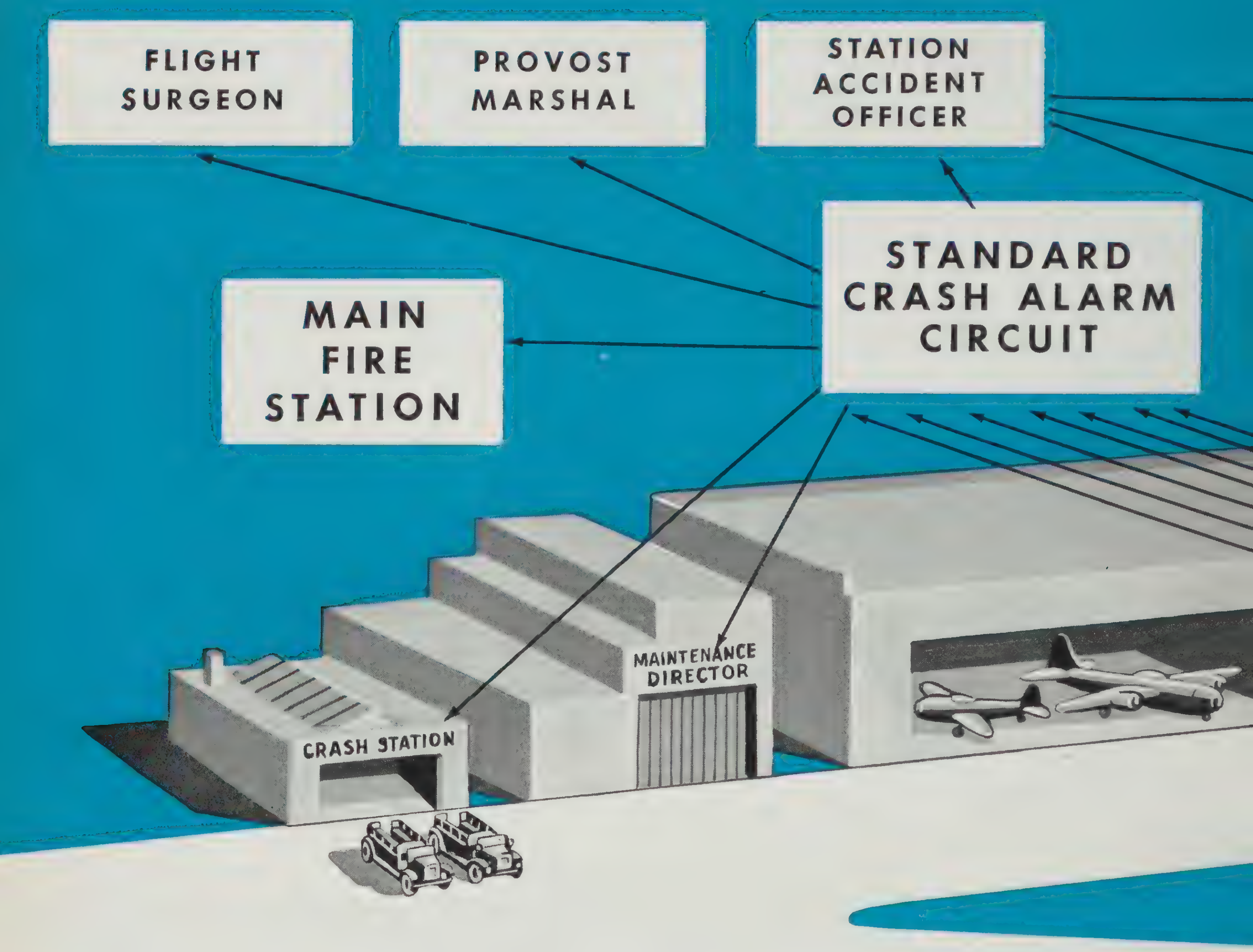
FRACTURE SITE	NO.
Fibula	14
Tibia	9
Humerus	5
Vertebra	3
"Ankle"	3
Rib	2
Metatarsal	2
Skull	1
Ulna	1
Astragalus	1
Total	41

SPRAIN SITE	NO.
Ankle	22
Knee	9
Back	5
Shoulder	1
Neck	1
Elbow	1
Wrist	1
Hip	1
Foot	1
Total	42



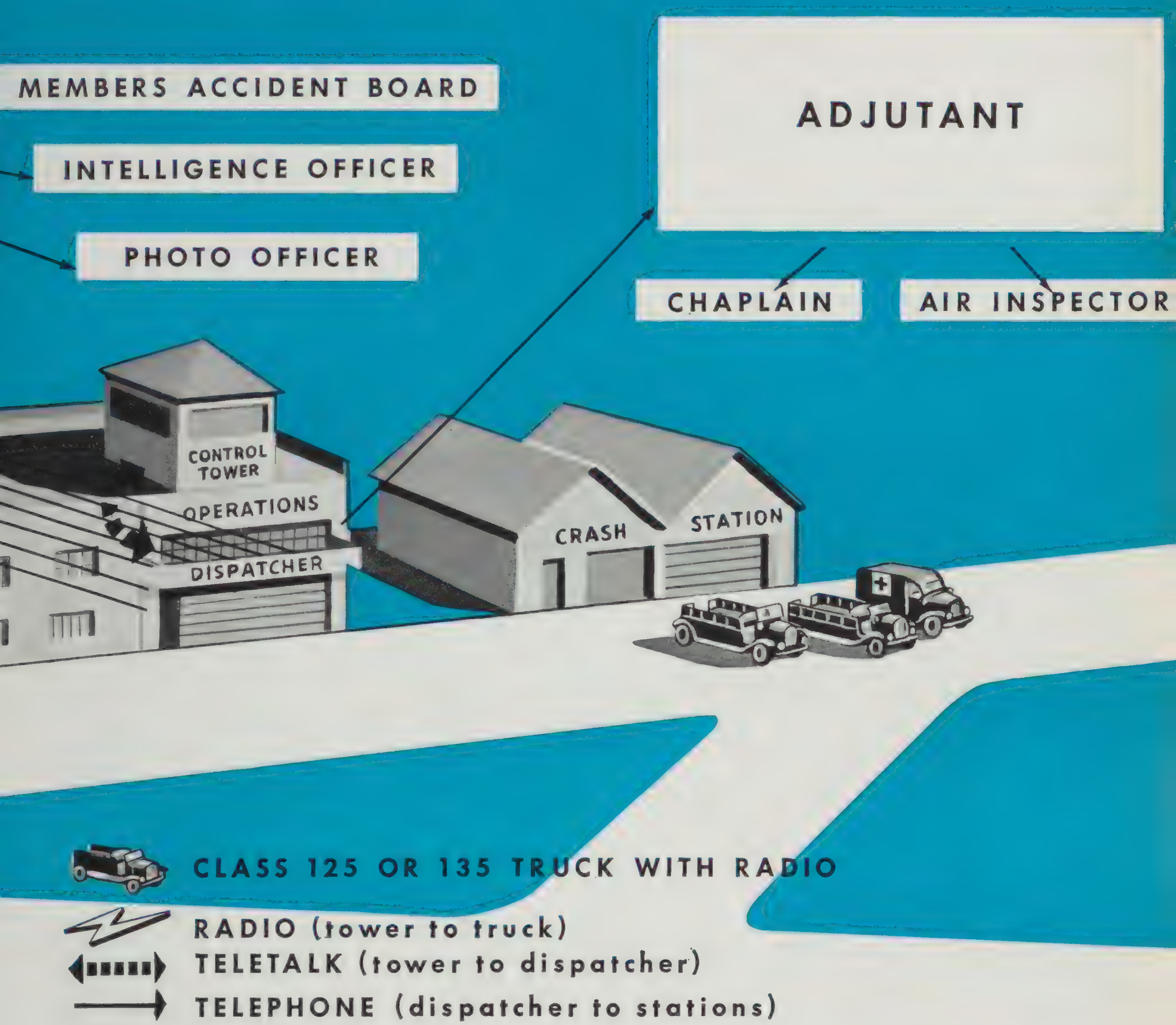


STANDARD PROCEDURE IN THE CRASH

Notification and response to crash. The base commander is responsible for the organization of crash procedures at his base. Under his direction there are two units in particular on which adequate crash procedures depend. These two groups are the aircraft fire fighting unit and the ambulance unit. The *operations officer,* the *aircraft maintenance officer* and the *base surgeon* are responsible for the integrated action of these two units.

The aircraft maintenance officer is responsible to the base commander for the training of crash crews and for the maintenance and operation of crash equipment (AAF Reg. 20-48). Medical personnel must be acquainted with the problems which crash crews face and solve. Base surgeons should cooperate with the aircraft maintenance officer, operations officer and fire chief in developing an instructional program in first-aid procedures to be used by the crash crews, especially the rescue men.

Speedy, efficient rescue procedures after a crash depend primarily on an efficient alarm system. The chart illustrates an adequate and efficient crash alarm hook-up, which should be a part of the aircraft accident control system on every base. In the event of a crash, the participation by medical personnel will be as follows:



One or more crash ambulances suitably equipped (Section 6-6) will be stationed at one or more crash stations on the flight line in close proximity to the crash trucks. The crew of each ambulance will consist of one driver and one enlisted man trained in crash rescue work and first aid. It is not necessary that this line ambulance be equipped with a 2-way radio because radio equipment will be found in the nearby crash truck.

For crashes on the field, the control tower will ordinarily be the first unit in the crash alarm hook-up to be aware of the crash. Such notification will come from the plane in the event of an impending crash or by direct observation in the event of an actual crash. In the first instance, the crash truck's radio will be tuned to the tower and will hear details of the tower's conversation with the aircraft. The aircraft, however, will not be heard since it uses a different frequency. Crash trucks, followed by the ambulance, will immediately proceed to the runway on which the aircraft has been cleared to land. In the second instance, they will proceed immediately to the site at which the crash has already occurred. The ambulance will be headed upwind with motor running and will park at a safe distance in order to give the crash trucks adequate room to operate. Equip-

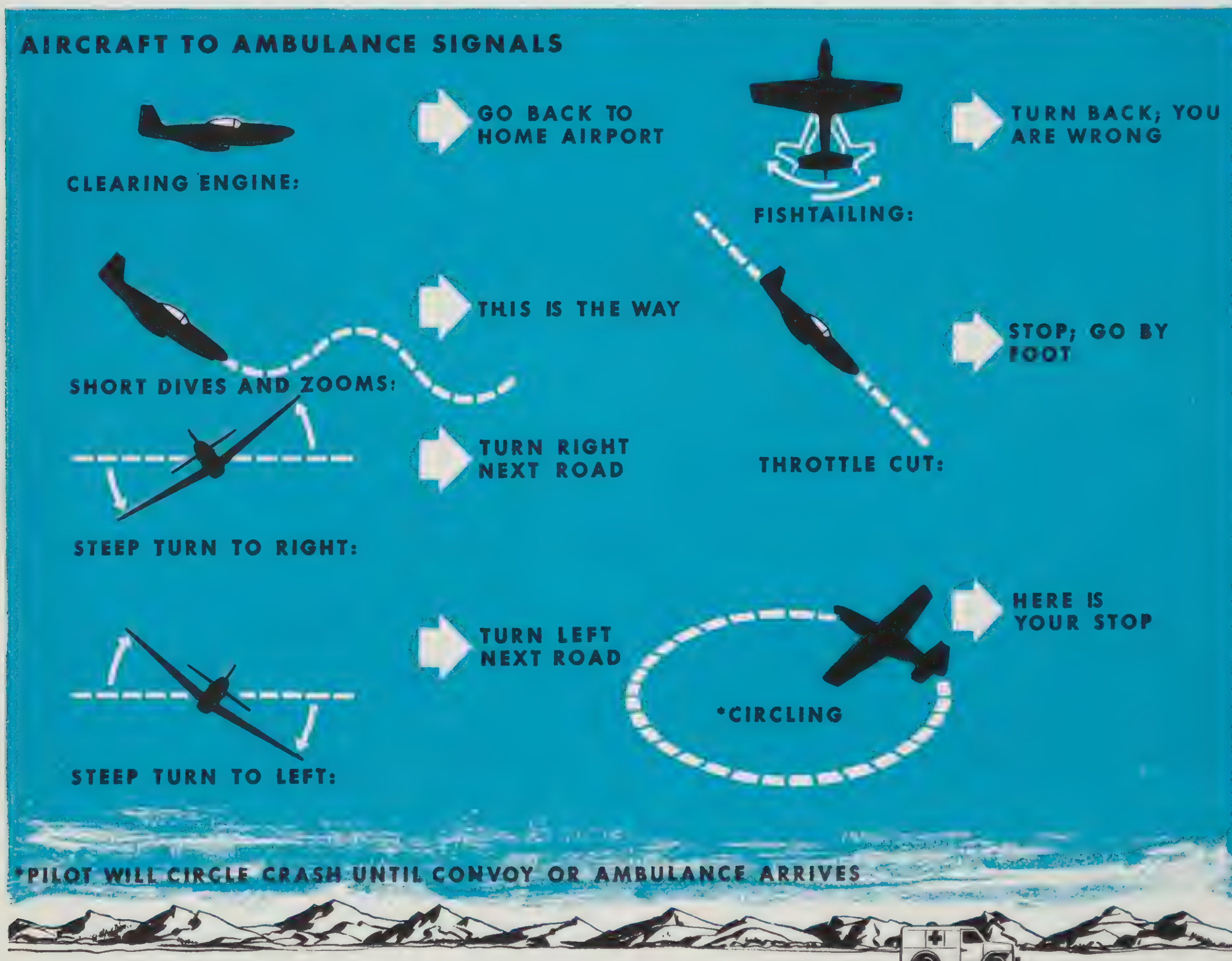
ment, including the fire extinguishers, should be removed from the ambulance and placed on the ground ready for use.

In the meantime, the control tower will have notified the operations office by teletalk and the operations dispatcher will have placed the crash alarm hook-up in operation. One of the stations on the crash hook-up will be in the station hospital. The post surgeon, flight surgeon or medical officer of the day, as the case may be, will proceed to the scene of the crash with the hospital crash ambulance, which is equipped with a 2-way radio.

If sufficient ambulances are available, a standby ambulance should be maintained at the station hospital. This ambulance will replace the line which will have responded to the accident.

When accidents occur off the air base, the base operations office will usually be the first to be notified. After obtaining all pertinent information the chief dispatcher will notify designated personnel by means of the crash alarm system. Especially important is the exact location of the crash by use of a grid map system. When accidents occur off the field the line ambulance will not respond. The hospital crash ambulance, which should contain a 2-way radio, will proceed immediately to a rendezvous point if a convoy is to be formed. This ambulance should carry the flight surgeon or other designated medical officer. This hospital ambulance will proceed immediately to the scene of the crash in the event a convoy is not formed. It will keep in constant communication with the control tower and with the liaison search plane, if such an aircraft is being utilized. The illustrated aircraft to ambulance signals should be employed.

Role of the Physician. Any physician responding to



crash calls should realize that his primary duty is to render medical assistance. He is not authorized or expected to participate in fire fighting and forcible entry procedures; the crash crew will take care of that. Medical officers should clearly understand that the fire chief or senior crew chief is in complete charge of all crash operations, directing fire fighting and rescue. Medical officers who are not trained in crash procedures should not expose themselves needlessly to the dangers which accompany an aircraft crash, especially when fire is present.

When fire results from an accident, time will usually not allow a medical officer to examine injured personnel preparatory to their removal from the aircraft. In such cases rescue procedures will have to be carried out as expeditiously as possible by the crash crew rescue men. It is on such occasions that previous training for which the base surgeon is in part responsible will be particularly valuable. As soon as any gasoline "spills" or other hazards have been eliminated, the medical officer in charge will proceed with the removal of any injured personnel from the aircraft. In this he will be aided by the rescue men and medical corpsmen.

Medical officers will find that many other problems are presented by aircrew accidents in which fatalities have occurred. Two main duties are identification and proper preparation of the dead.

Identification. Every precaution must be taken to identify bodies properly, to recover dismembered parts, and to collect personal effects. Use of the recently introduced pouch, human remains, often simplifies transportation of bodies. The pouch is a rubberized zipper bag which is available as a nonexpendable item through the Air Technical Service Command.

Upon arrival at the scene, a sketch should be made of the location of the wreckage and the position of each body in relation to it. Such a sketch aids not only in identification but also in accident investigation. An Emergency Medical Tag should be tied to each body. Bodies can be distinguished by number if identification cannot readily be established. Every effort should be made to complete identification at the scene, because positions of the bodies and other factors in relationship to the scene are clues.

Before a body is disturbed even slightly, the immediate area should be searched meticulously for identification tags, rings, jewelry, bracelets, and watches, especially if the body has been burned. Parachute harness and clothing should be removed bit by bit, layer by layer, and each fragment carefully examined. When the body is moved, the area beneath should receive the same attention.

Besides methods already indicated, the following means of identification can be used, either separately or in combination:

1. Position in aircraft (e.g., pilot, left seat; co-pilot, right-seat).
2. Names and laundry marks on clothing. An enlisted man's laundry mark usually comprises the initial of his last name, and the last four digits of his serial number. Even on an extremely burned body, laundry mark on back of shorts generally does not burn because the mark is directly under the belt. This mark often proves to be the only means of identification.
3. Wallets and contents, such as AGO passes, pay data cards.
4. Parachute number. This is not reliable in large aircraft, however, since parachutes are frequently interchanged among those aboard.
5. Insignia, particularly indications of flying rating, corps, grade.
6. Scars, defects, deformities, birth marks (WD AGO Form No. 63 and 64 should be consulted).
7. Tattoos.
8. Color, quantity, and distribution of hair.
9. Height and weight.
10. Clothing and shoe size.
11. Fingerprints.
12. Blood type.
13. Dental identification often plays the key role. When bodies are so badly burned or other mutilated that they cannot be recognized, and identifying articles are also damaged or lost, the teeth may furnish the only clues for identification. Unless it is the last resort, dental identification should be used as a check rather than as initial identification. Dental identification is best performed at the post-mortem examination, where good light and facilities for cleaning the mouth and teeth are available.

It is most important to have the Dental Identification Records at hand at the time of the post-mortem examination. Attempts at charting the mouths of crash victims for later comparison with the original records are frequently inaccurate and unsatisfactory because of the condition of the remains. Artifacts are less likely to be confused with restorations, for example, when the examiner knows what to look for.

It is important to finish with one body before proceeding to the next, in order to prevent confusion. All data should be written.

While checking identification, it would be advan-

tageous to make notes as to possible manner in which death occurred, such as breaking of seats, safety belts, dislodgment of turret, and the like. This will facilitate accurate preparation of AAF Form No. 205 (see Section 5-2).

The coroner. The local coroner is to be given "every reasonable opportunity to examine the body, either before or after its removal to a military hospital or elsewhere," provided the examination may be conducted without jeopardy to security of military information or interference with official duties of military personnel. But bodies must be removed from the scene expeditiously, whether or not there has been a coroner's inquest at the scene. Delay in waiting for a coroner to reach the scene is "intolerable."

It is highly desirable to establish and maintain personal contact with the local coroner. If dealt with tactfully, coroners are not inclined to interfere with handling of remains of military personnel by military authorities. An arrangement to notify the coroner by telephone as to the number of deaths in any crash, giving the names of the killed, is usually satisfactory. Provision should be made to have the undertaker furnish a copy of each death certificate to the local coroner.

Disposal of personal effects. When identification of each body has been completed and the clothing has been removed and searched, the medical officer should see that all personal effects are sealed in an envelope and turned over to the summary court officer appointed for this purpose. A receipt should be obtained. Clothing issued by the government, except that necessary for burial, must be turned in with other individual equipment to a unit or other supply officer.

Public relations. It is important that no information regarding the identity of the victims or nature of the casualties to be released to the press or to any unauthorized civilians except by a public relations officer or other officer designated by the commander of the nearest station.

It is the responsibility of the commanding officer of each individual's home station to notify next of kin before identification is released to the public.

Necropsy. Army Regulations require that necropsy be performed if necessary to determine the cause of death. Autopsies should be performed wherever possible, and the information collected is used not only for completing AAF Form 205 but also is sent to the Director, Army Institute of Pathology, Army Medical Museum, Washington, D. C. In many instances, the cause may seem obvious. In others, however, the external injuries may appear inadequate to account for the fatal outcome. External evidence may be minimal or even entirely lacking in cases of severe trauma. Even where the cause of death seems evident, other injuries of equal significance may be demonstrable only at autopsy.

Preparation of remains. The purchasing and contracting officer, who is usually the quartermaster, and the surgeon or the medical officer representing the surgeon are responsible for the proper preparation of remains so that they will arrive at their destination in acceptable condition. These two officers must inspect the body immediately after death, again after embalming but while unclothed, and once again after it is clothed and in the casket. Responsibility of the surgeon does not end until the remains are removed from the hospital or undertaker's establishment by the quartermaster for interment or shipment. The medical officer should thus be familiar with the principles of such preparation.

When, because of condition of the remains or mode of death, state health regulations require that the casket be shipped sealed, army rules specify that the body be placed in an hermetically sealed casket if shipment is at government expense within the continental U. S. The sanitary laws of all states in which the remains are transported must be met. Whenever there is doubt as to the condition in which the remains will reach the destination, a sealed casket will be used.

A sealed metal-lined casket, tested to make sure that it is water-tight, is advisable for bodies which have been dismembered, burned or become distended with gas.

In many cases the body is so badly mangled that the usual methods of embalming are not satisfactory. In such instances the undertaker will generally appreciate any suggestions, as he must make sure that the remains reach their destination in acceptable condition. There are numerous suggestions relating to the preparation of remains of deceased military personnel in a letter from the Office of the Adjutant General. A general embalming procedure such as the following is recommended:

The body and recoverable parts should be thoroughly washed. The trunk, viscera, and severed parts should then be immersed in a strong solution of formaldehyde (approximately 10%) and allowed to remain there as long as possible. Viscera should be punctured with a trocar so that the formaldehyde will act internally and externally. Body cavities

should be thoroughly aspirated and then saturated with the formaldehyde. When embalming is completed, component parts of the body should be wrapped in muslin and assembled as nearly as possible in the body's natural conformation.

The whole should then be wrapped in muslin and put in the metal inner liner, in which three or four inches of sawdust, with cotton or wool filling the remaining empty space in the liner.

A neatly folded uniform should be placed under the glass lid of the inner liner. Transparent fingernail lacquer will delay corrosion of buttons and insignia. Uniform is supplied from individual's own wardrobe. If this is not feasible, as may happen when death occurs at considerable distance from the victim's station, it is customary for the quartermaster to supply a uniform. The quartermaster is authorized to buy a uniform for an officer in such a case.

Identification tags, if available, are to be shipped with the remains—one on the body, worn in the customary manner, and the other attached to the outside of the casket about 18 inches from the head.

A sealed casket is sometimes opened at its destination, on insistence of the family. The medical officer should suggest to the base commander that he write the undertaker at the destination, requesting that the family be discreetly urged to forego opening the casket. A tactful explanation of the nature of the death and condition of the remains, together with a sympathetic assurance as to the correct identity, will usually bring withdrawal of the request for opening the casket and spare additional grief.

Cremation may be provided at government expense if the responsible relative requests. It is best not to ask for authority to cremate the body, but to explain simply that such may be done at government expense if requested. In cases of partial incineration, severe dismemberment, fragmentation, and decomposition, cremation is the most satisfactory method, especially when the remains have to be shipped over long distances.

Reports. The medical officer on the Aircraft Accident Board should prepare the Medical Officer's Report of Aircraft Accident (WD AAF Form 205). In addition, there are certain reports routinely required in deaths of military personnel:

1. The commanding officer of the deceased's post and the commanding officer of the deceased' squadron or other unit must be notified immediately. This notification must include, so far as practicable, the full name, grade, and serial number of the decedant; his unit, the date, place, and cause of death; line of duty status; statement as to whether or not misconduct is indicated; and—if a permanent civilian employee—the arm, service or bureau by which he was employed. Death or injury while riding in government aircraft is considered "Line of Duty—Yes," unless misconduct or negligence is a contributing factor.

2. All deaths at army stations or in army commands must be reported to local civil health authorities. Medical officers should familiarize themselves with local laws in this regard. Reports directly to the Bureau of the census in Washington are no longer required.

3. A complete copy of every autopsy protocol must be sent directly to the Director, Army Institute of Pathology, Army Medical Museum, Washington, D. C.

4. A register card (WD AGO Form No. 8-24 or WD MW Form 52) must be prepared for anyone in a command who dies outside a hospital.

Conclusion

Whether the medical officer's responsibilities are expressly stated in regulations or are only implied, any criticism connected with the care of the body, from the time of death to the time of burial, will eventually reach the medical officer. He should satisfy himself of the undertaker's ability and integrity, and check every step in the care of the remains until they are loaded for transportation.

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INJURIES IN AIRCRAFT ACCIDENTS

Experience with injuries in aircraft accidents indicates that just below the level of impact that causes sudden death there is a narrow range which produces multiple internal injuries and permits survival. This is the range of over-all maximum tolerance of the body to abruptly applied force.

Personnel subjected to this barely survivable range of impact are often unconscious. As a rule hemorrhage from superficial lacerations is not important. The blood pressure is usually normal. Physical signs and symptoms are variable and often obscure in origin. Diagnoses of "shock" and cerebral concussion are routinely made. Within a few hours the patient either improves or develops symptoms of increasing severity. If the patient improves, an uncomplicated recovery is the rule. If he does not improve, the problem is to determine whether the adverse clinical course is due to injury within the skull, thorax, or abdomen; to define concussion and shock in terms of injury; and to institute treatment accordingly.

Superficial lesions and fractures of bones are of lesser importance from the standpoint of survival of the patient than injuries of internal organs. Internal injuries may not all be due to external trauma. When two parts of the body are decelerated at different rates, the connections between the parts are placed under stress which is proportionate to the difference of the rates of deceleration. If the pilot is sitting erectly and an abrupt, large force acts on him from seat to head, the axial bony framework of the body from the midfemoral region and pelvis to the vertex of the skull will be decelerated rapidly. The viscera, being more mobile and elastic, will continue to descend toward the seat and will be restrained by attachments to bony structures, and by contact with other elastic bodily structures. This leads at times to the development of lesions which are independent, so far as can be determined, of direct contact with any external restraint.

The lesions described in the following paragraphs are encountered in the occupants principally of two seated single and twin-engined training aircraft which have crashed.

The Head

Etiology. The head is injured in 80% to 90% of aircraft accidents.

The principal parts of aircraft structure which make contact with the head are:

1. The proximal margin of the frame of the anterior section of the canopy.
2. The "cowling-instrument panel-cockpit" assembly.
3. Structures along the lateral walls of the pilot compartment.
4. The instrument panel.
5. The shattered glass of canopy or windshield.

When the canopy is open, or when plexi-glass is shattered with the canopy closed, the vertical portion of the anterior section of the canopy is occasionally the source of severe craniofacial lesions. The forces need not be great enough to produce any other bodily injury, especially when the occupant of the cockpit is leaning to one side to get a better view of the ground.

The structure known as the "cowling-instrument panel-cockpit" assembly is the most serious source of injury to the head. The cowling forms the anterior and lateral margin of the cockpits of several types of training planes. Its sharp margin is poorly shielded and projects backward at a dangerous level. Motion of the head directly or obliquely forward during deceleration results in contact with this structure in many cases. The injuries vary from minor bruises of the face and forehead to partial decapitation.

The instrument panel in some types of training planes is set well forward in the cockpits and has not yet been demonstrated as a source of injury to the head in any case in which cockpit structure has remained reasonably intact and the safety belt tightly fastened. In other types of training aircraft the instrument panel is closer to the face of the pilot and is a point of contact in some cases where forces involved are relatively small.

Structures along the lateral walls of pilot compartments are numerous and need not be mentioned in detail but they are, at times, responsible for injury not only to the head but also to other parts of the body. This has been particularly the case in one type of aircraft in which heavy metal bulkheads run upward and medially on each side of the pilot compartment. These girders apparently serve as important supports to the pilot compartment and wing assemblies but they are unshielded, sharp and dangerous in a crash.

The glass of the windshield, canopy and pilot compartment is commonly shattered during contact de-

celeration. Lacerations of the face, neck and arms are occasionally caused by flying particles of glass. Although fragments of glass have been found in wounds in several cases, they have caused no fatal injuries. The greatest danger is to the eyes.

The head, especially the scalp and forehead, is occasionally injured when the aircraft noses over at high velocity in such a way as to crush the top of the canopy. In general, however, the crash-bar or protective turn-over assembly has served a useful purpose and undoubtedly has prevented serious injury in these cases, even though in several instances the head of the pilot made a deep imprint in the ground.

Pathology. Principal points of contact of the head with aircraft structure are anterior to a coronal plane passing through each temporal region. Facial prominences are especially liable to injury in the following order of frequency: supraorbital ridges, forehead, nasal bones, zygomatic arches, chin, and eyes.

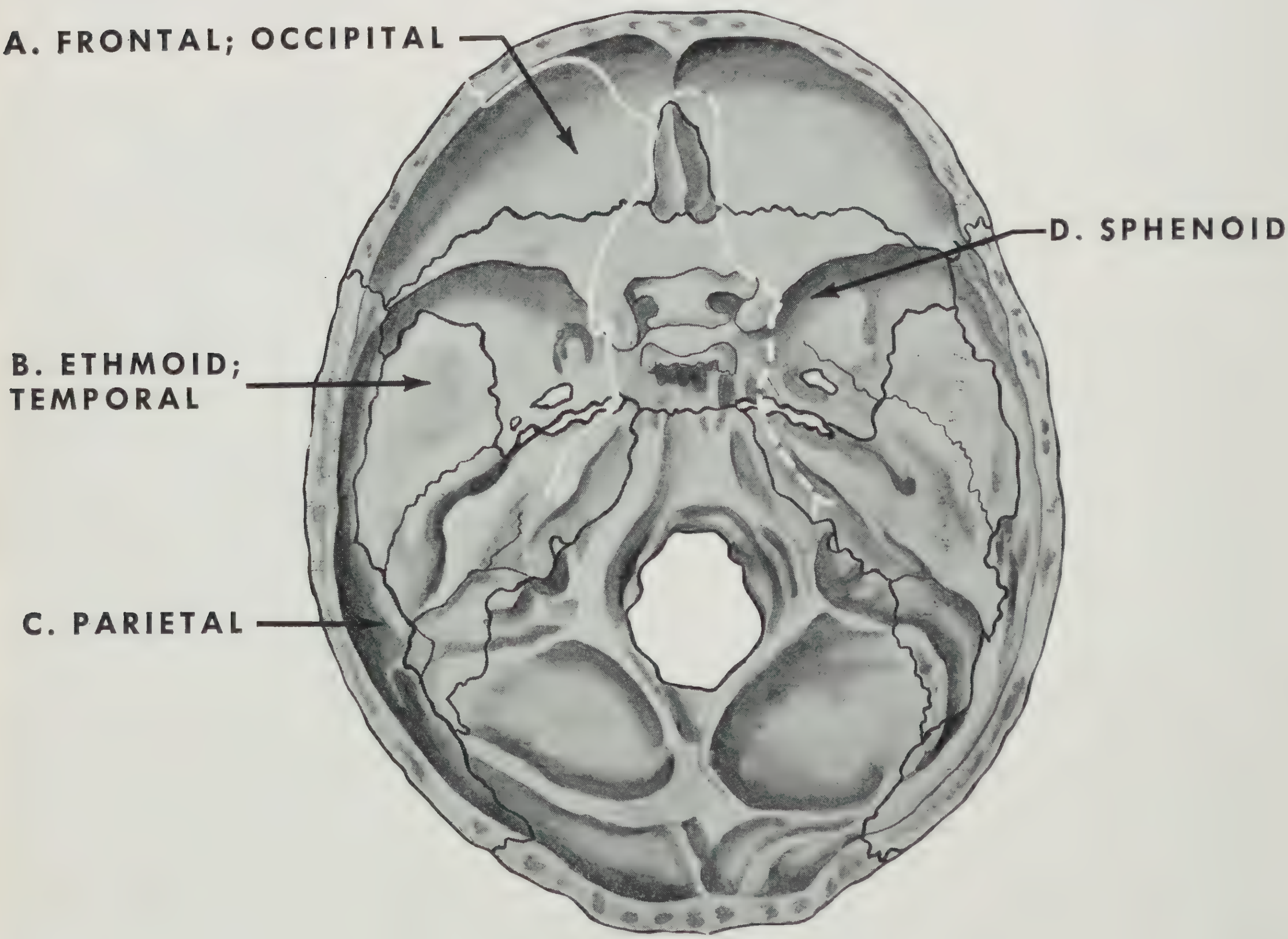
The general types of lesions in order of increasing magnitude are abrasions, contusions, lacerations, fractures and displacements of bones along suture lines. Among superficial lesions, traumatic injuries of the eyes are most important. Fractures of facial bones below the level of the orbits usually are not, in themselves, serious although quite common. They are to be regarded as serious, however, when the force is transmitted upward and backward in such a way that fractures of bones bounding the cranial vault occur. Therefore, severe fractures of the nasal, zygomatic and frontal bones are types of lesions which are most serious because intracranial injury is a likely complication.

In these cases, films of the skull are of little value in determining the true extent of the fractures or the probable location of intracerebral or ocular injury.

X-ray of skull, viewed from right side, showing fractures of the superior maxillary, malar and frontal bones. The extension of the fracture into the wall of the frontal sinus is indicated by the arrow. A case of this type is almost certain to have anterior basilar fractures which are not visualized by x-ray.

Extension of fractures beyond the limits of demonstrable lines is the rule. The usual pattern of extension of severe nasal and supraorbital fractures is toward the midline. As the fracture lines on either side approach the lateral margin of the cribriform plate of the ethmoid bone, they turn posteriorly in the orbital plate of the frontal bone and pass backward through the lesser wing of the sphenoid bone. The course from this region is usually backward and outward through the greater wing of the sphenoid bone toward the apex of the petrous portion of the temporal bone. From this point, they may pass into the temporal bone but it is uncommon for the fracture to involve the occipital bone. As a result of this pattern of extension, basilar fronto-temporal injury of the brain with or without lesions of the olfactory nerves where fibres pass through the cribriform plate is most likely. Involvement of the bones of the orbital wall or frontal and maxillary sinuses may cause local disturbances, the most important of which is an ocular muscle imbalance due either to displacement of bony attachments or injuries of the soft tissues.

A variety of cerebral lesions are encountered in fatal aircraft accidents. Subarachnoid hemorrhage without cranial fracture is usually mild. Intracerebral hemorrhage and subdural hemorrhage with-



USUAL SITE (UNILATERAL OR BILATERAL) OF BASAL FRACTURE

out a fracture of the skull are uncommon and rare, respectively. At necropsy, lacerations are found only with fracture of the skull. Survival from open compound fractures is unusual. Contrecoup lesions are not seen in cases with maxillo-facial-frontal fractures.

Specific Injuries and Treatment.

CEREBRAL

The diagnosis is not always easy. A history of cranial trauma, the presence of a contusion or laceration of the scalp, focal neurological signs, pupillary changes, convulsions, and bloody spinal fluid indicate cerebral injury.

Treatment. The factors causing difficulty in the treatment of cerebral injuries, e.g. edema or bleeding within the skull giving rise to increased intracranial pressure, diminished circulating volume to the brain, and secondary anoxia of vital centers, are common knowledge. Perhaps less well known are the factors which modify the treatment of craniocerebral injuries.

The scalp has an excellent blood supply and heals well.

The skull is relatively resistant to osteomyelitis.

The dura, if intact, is a powerful barrier to the spread of infection.

Cerebral tissue resists infection well provided there is free drainage.

Surgical manipulations within the skull cannot be carried out effectively in the absence of x-ray and other special apparatus.

The tactical flight surgeon will be responsible for rendering emergency medical treatment to these patients in advanced medical installations (Squadron and Group Aid Stations). Bearing the above factors in mind, emergency treatment may be outlined as follows:

A. Closed head injuries.

(1) Keep the patient quiet.

(2) Up to 0.3 gm of sodium phenobarbital may be given for restlessness or convulsions.

(3) Avoid opiates.

(4) Place the unconscious patient on his side so that he has a free airway.

(5) Treat "shock" but look for its etiology elsewhere as it is not a common complication of injury to the head.

(6) Make a brief notation on the patient's record of gross neurologic findings (state of consciousness, size of pupils, paralysis, etc.), the character and manner of infliction of the wound, and the amount and time of administration of any medication. Note the pulse rate, respiratory rate, and temperature every half hour.

(7) Evacuate to the nearest hospital.

B. Open head injuries.

(1) Minor wounds of the scalp (no evidence of concussion, fracture, or of perforation of the meningeal spaces).

(a) Shave the scalp for 1½ to 3 inches around the wound.

(b) Remove all gross debris.

(c) Cleanse scalp and wound edges with neutral soap and saline.

(d) Debride thoroughly.

(e) "Frost" wound with sulfanilamide powder.

(f) Close with interrupted silk sutures (not buried) without drainage.

(g) Sterile pressure dressing.

(2) Major injuries.

(a) Gently separate the edges of the wound, removing superficial debris and blood clot, gently elevate any depressed fragment of bone, cover wound with sterile gauze.

(b) With the gauze in place, shave the scalp for 3 inches around the wound and wash the skin with soap and water.

(c) Remove gauze, "frost" wound with sulfanilamide powder and apply a large secure dressing but do not pack.

(d) Make necessary records as for closed injury. Evacuate on priority to the nearest hospital wherein adequate surgical and post-operative care are feasible. Craniocerebral injuries tolerate air evacuation very well, and in general travel better pre-operatively than after operation has been performed.

MAXILLOFACIAL

The airman with a maxillofacial injury poses 4 separate therapeutic problems:

Hemostasis.

Maintenance of an airway.

Restoration of function.

Attainment of good cosmetic results.

a. Hemostasis. The head and neck are quite vascular, and severe primary hemorrhage may occur. If bleeding cannot be controlled by packing or by pressure dressing, the responsible vessel must be isolated and ligated. Rarely, it is necessary to ligate the external carotid artery.

b. Maintenance of an airway. If respiratory embarrassment should occur, soft tissues may be kept out of the throat by keeping the patient prone on a litter

with the head partially pendent over the edge of the canvas but supported by a head strap or strips of blanket tied to the poles. A pin or suture may be passed through the tongue or other prolapsing soft tissue so that the structures may be pulled forward to clear the airway and patency maintained by attaching the connecting suture to the shirt or a chest band. Laryngeal edema may develop rapidly. Any case which begins to show the signs and symptoms of respiratory embarrassment should be observed closely and a tracheotomy set kept at the bedside. A low tracheotomy is preferable to any other method of artificial airway.

c. Restoration of function and attainment of good cosmetic results. Complete roentgenological studies should be done as soon as the patient's condition will allow. The preliminary treatment of maxillofacial injuries should begin as soon as possible, preferably within the first 6 to 12 hours. The affected area is cleansed thoroughly and all easily accessible foreign bodies are picked out. Other foreign bodies are taken care of as part of the subsequent definitive treatment. A moderate debridement is performed. It is important to eliminate all devitalized and contaminated tissue in order to reduce the possibilities of secondary infection. However, the size of the wound should be kept as small as compatible with adequate therapy, and all possible tissue should be saved in order to minimize the later deformity, scarring and reparative procedures. Pockets and "dead spaces" should be searched out and eliminated. These areas may be closed with deep sutures if the situation warrants, but usually it is better to convert the pocket into part of the major wound. Complete hemostasis is essential. Bony fragments and prolapsed soft tissues should be returned to as nearly normal position as possible, and supported by splints, loose packing or ties. Sulfonamides are applied locally and systemically.

Since all maxillofacial wounds are considered to be contaminated and the major complication of this type of injury is secondary infection, adequate drainage of all parts of the wound is a primary consideration.

The treatment of patients with maxillofacial injuries should be carried out under local anesthesia whenever possible. If a general anesthetic is necessary, intratracheal ether is the method of choice.

An important part of the treatment will be the reduction and fixation of fractures of the nasal, malar, maxillary, and mandibular bones. For details of the procedures used refer to standard texts.

OCULAR

Some general rules for the immediate care of ocular injuries are usually applicable.

a. Cleanse and anesthetize.

The eye should be cleansed by copious irrigation with physiologic saline, sterile water, or even tap water in an emergency. The skin about the eye should be washed with soap and water. A local anesthetic is then instilled. In order of usual preference these are:

(1) 0.5% Pontocain.

(2) 1.0% Holocain. An occasional reaction from sensitivity obscures the original lesion.

(3) 1.0% Butyn. A relatively large number of patients are sensitive to the drug.

(4) 4.0% to 10.0% Cocain. The drug softens and dehydrates the cornea and should not be used if other drugs are available.

b. Examine.

If the patient's condition and the local facilities permit the following should be determined:

(1) Visual acuity: This should be determined early in order to overcome the patient's apprehension concerning blindness assuming that this has not occurred.

(2) Extraocular movements in the 6 cardinal directions.

(3) Motor function and injuries of the lids. An ecchymosis of the lower lid with no apparent cause may mean a basilar skull fracture.

(4) Search for conjunctival and corneal lacerations or abrasions.

c. Detailed therapy.

Details regarding the handling of palpebral lacerations and injuries of the globe, both perforating and non-perforating may be found in standard texts.

d. Adjunctive measures.

(1) 1.0% solution of atropine should be instilled in any injury of the globe *except* contusion. If a non-perforated contusion exists, regardless of other lesions present, the use of atropine is contraindicated for at least 72 hours after the accident because this may cause damaging intraocular hemorrhage. Even at this time the use of a milder type of cycloplegic, such as homatropine, is preferable.

(2) An antiseptic ophthalmic ointment should be employed with each dressing.

(3) Ocular dressings should be changed daily and signs of infection sought out. These include increasing cloudiness of the cornea or of the aqueous humor; a small pupil which reacts sluggishly to light and is

difficult to dilate with atropine; decreased visual acuity; pain, redness, photophobia, blepharospasm.

(4) Treatment of ocular infections will depend on individual circumstances and may include the use of hot wet packs, sulfonamides, and penicillin.

The Neck

Serious injuries of the skin or viscera of the neck are uncommon in aircraft accidents where there is any chance for survival of the occupants. Extensive lesions of the neck often accompany mutilation of the face and skull, but in these instances cervical lesions are invariably incidental findings. (For fractures of cervical vertebrae see below.)

Upper Extremities

Upper arm. Contusions are common on the anterior and lateral aspect of the midportion of each upper

Transverse fracture of the midshaft of the humerus.

Fracture of the surgical neck of the humerus.

Fracture of the body of the scapula.

arm. Occasionally there are lacerations in this location, but when lacerations are present, there is usually a compound fracture of the humerus.

Fractures of the humerus and clavicle are common but they are usually simple and are occasionally accompanied by dislocation of the shoulder joint or fracture of the articular process of the scapula.

Forearm. Contusions, lacerations and fractures of forearms are not as common as corresponding lesions of the upper arms. When lesions occur, they are usually near the elbow joint or just proximal to the wrist joint. As a result of variable positions, injuries to the arms are variable so that even if the magnitude and direction of forces are fairly well known, good predictions of injuries to the arms cannot be made.

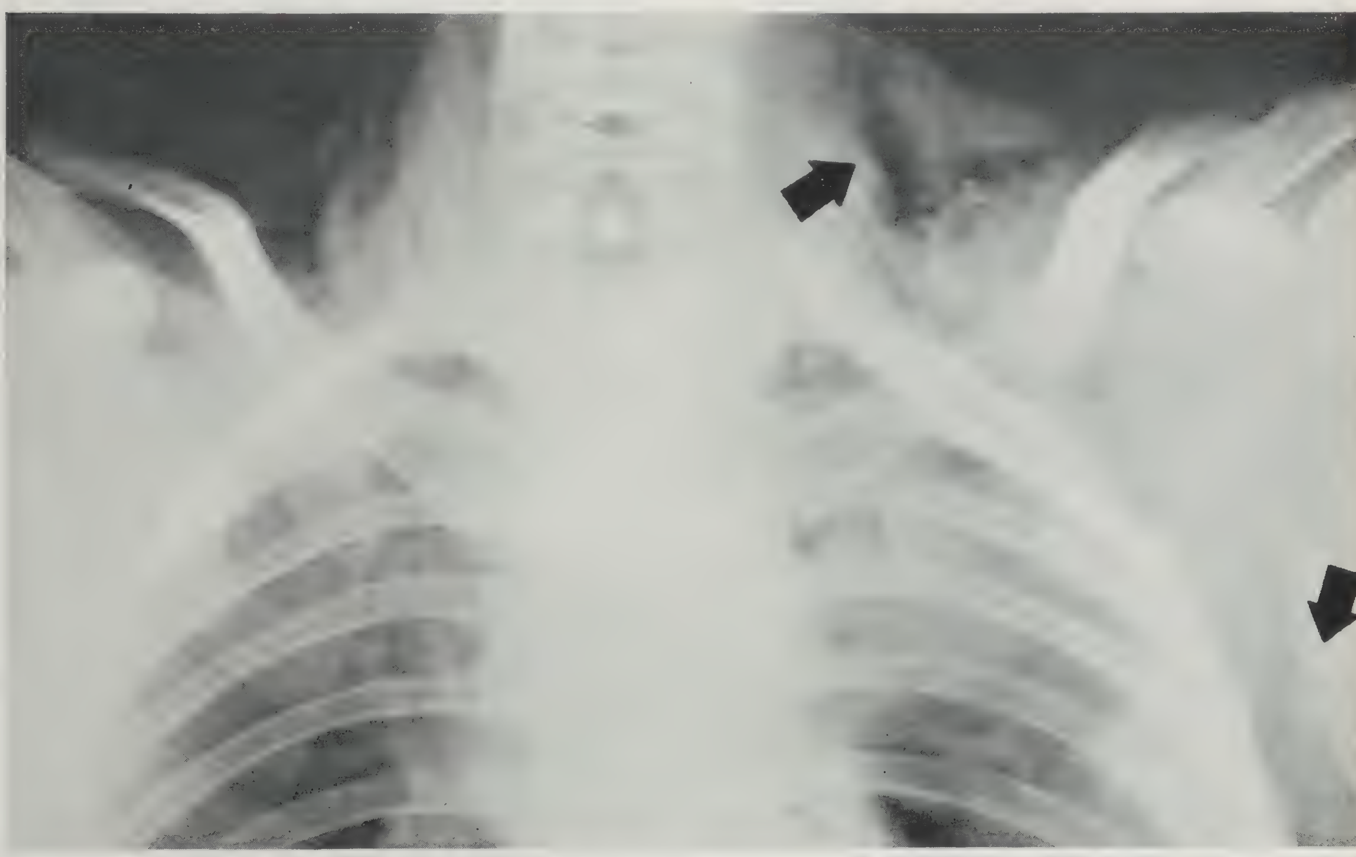
Thoracic wall

Superficial abrasions and contusions are common. Lacerations of the skin are rare. Fractures of the sternum, costal cartilages and ribs are often encountered but there is rarely any external compounding of these fractures. As a rule, fractures of the vertebrae are not conspicuous because they are of the compression type. Fractures of ribs and costal cartilages are often symmetrical. The second and third costal cartilages, often with an accompanying fracture of the upper one-third of the sternum, are most commonly involved. The third to the eighth ribs are the most common sites of fractures and the lesions are usually between the anterior and posterior axillary lines. When fractures are multiple, one or more jagged edges of the ribs frequently project into the lungs.

It has been possible to determine the points of contact between aircraft structure and the thorax in a few cases, but it is often difficult to reconstruct a probable picture of the genesis of the lesions. Up to the present time there has been little evidence that the control stick, although it is frequently broken, is the cause of thoracic fractures or lacerations.

Mediastinal lesions

Lesions of the mediastinum are common in fatal cases and it is believed that they contribute to the clinical picture in some surviving cases. Hemorrhage



Mediastinal emphysema with extension of the air, as indicated by the arrows, into the subcutaneous tissues of the neck and thoracic wall.

into the mediastinum is the most common lesion. In several cases of "shock" and concussion, x-rays have shown a broad mediastinal shadow which was probably due to hemorrhage. In one case emphysema of the mediastinum developed in conjunction with emphysema of tissues of the neck and thoracic wall. There was dysphagia and progressive circulatory failure. Cardiac sounds became almost inaudible. Surgical exploration of the superior mediastinum permitted the air to escape. The patient recovered. It is believed that the mediastinal emphysema was due to a laceration near the hilum of the left lung.

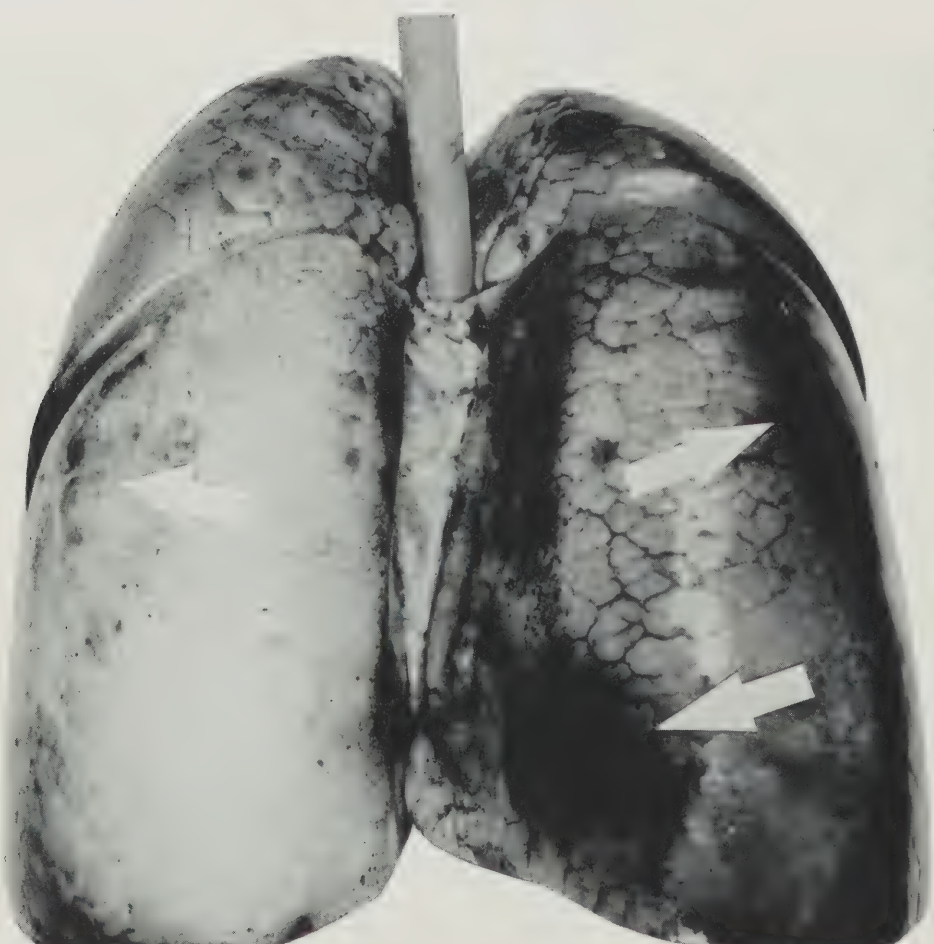
Pleuro-pulmonary lesions

Lesions of the lungs and pleura are common and may be severe even in the absence of fracture of the thoracic wall. The most important findings in the lungs are *hemorrhage, laceration,* and *emphysema.* These lesions may be grouped together and described under the general term, "traumatic pneumonosis."

Pathology. Hemorrhage usually is due to rupture of small blood vessels because of excessive traction, direct trauma, high intravascular pressure or high intra-alveolar pressure. When hemorrhages occur beneath the parietal pleura, they usually occur at intercostal spaces, some intercostal muscle fibers commonly are torn, and there may be increased mobility of ribs at costovertebral junctions as a result of tearing of ligamentous attachments.

When hemorrhages occur at the roots of the lungs, they usually are beneath the pleural reflections at the hila or at the base of the heart. Frequently they are associated with pleural lacerations at the hila and they may be the source of an hemothorax.

Hemorrhages in the lungs are usually subpleural and wedge-shaped, being distributed along the borders of all lobes. They involve the parenchyma in subpleural areas and occasionally are scattered irregularly throughout one or more lobes. They may be distributed in such a way that they resemble the



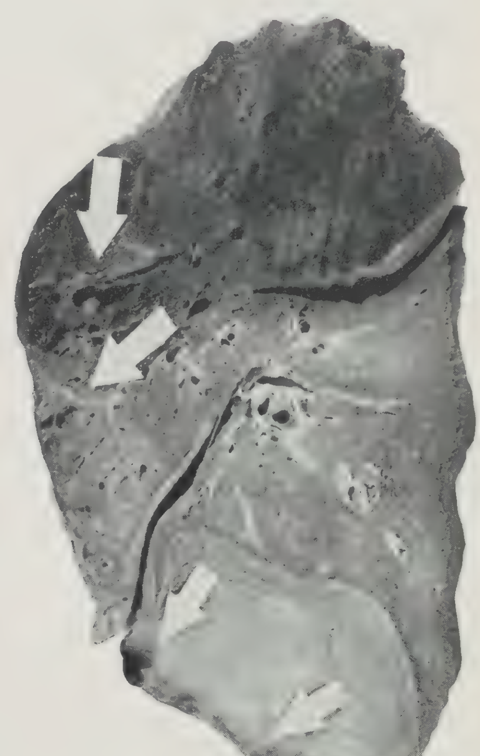
Traumatic pneumonosis. There are large subpleural and intrapulmonary hemorrhages in the lower lobe of the right lung. The arrow overlying the lower lobe of the left lung is directed toward subpleural emphysematous blebs that elevate the pleura slightly.

early stages of acute bronchopneumonia and in these instances there is a mottling of the lung fields which is indistinguishable from an early pneumonic process. In milder cases hemorrhage is principally interstitial and atelectasis may be conspicuous.

Hemorrhage into the lungs may be complicated by irregular lacerations which are usually superficial and involve the pleura, resulting in hemopneumothorax. Common locations of lacerations are over the convexity of each lower lobe in the anterior axillary line, in the base of each lower lobe and in the sulcus between the right middle and lower lobes. Lacerations over the convexity of the lower lobes, when not due to internal compounding of fractured ribs, are usually small and multiple, ranging along the courses of approximation of the lugs to ribs or intercostal spaces. Lacerations in the bases of the lungs are frequently multiple and deep, radiating from the center toward the periphery over the area in contact with the dome of the diaphragm. They are more common in the base of the right lung. Lacerations in the sulcus between the middle and lower lobes of the right lung are especially common. They usually begin near the hilum and extend laterally from the hilum, often being continuous with hilar, pleural or pleuropericardial lacerations.

Hemorrhage into the lungs is often complicated by acute traumatic emphysema. Emphysema may exist in the absence of other significant pulmonary changes. It is usually most conspicuous beneath the

Coronal section of lungs with traumatic pneumonosis viewed from behind. The dark areas, involving about four fifths of the parenchyma, are zones of intra-alveolar and interstitial hemorrhage. Multiple large emphysematous cysts are present, especially in each lower lobe. There is a laceration extending from the diaphragmatic surface toward the primary descending bronchus of the lower lobe of the left lung.



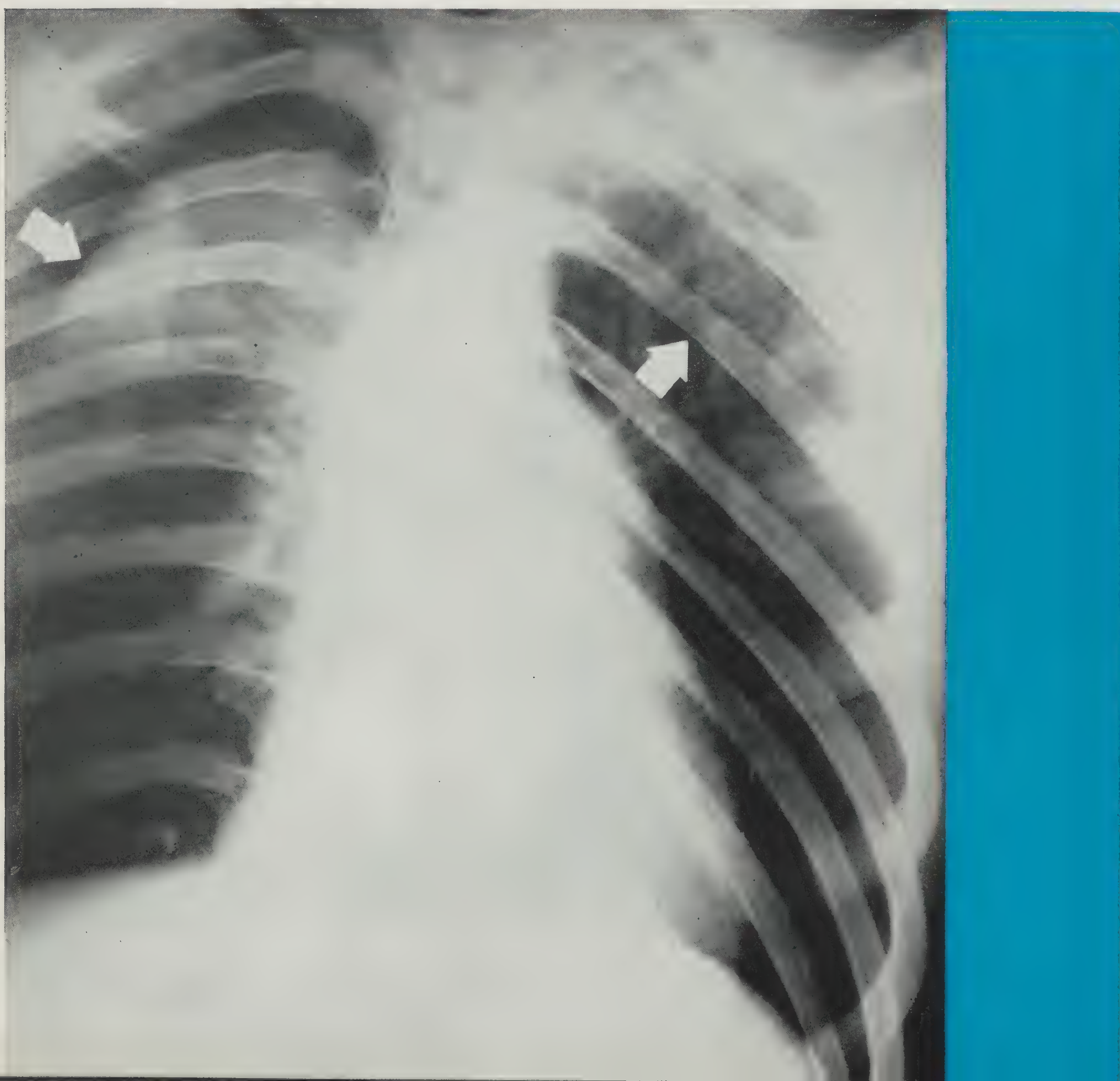
Coronal section of the right lung showing parenchymal changes in severe traumatic pneumonosis. The arrow at the top is directed toward extensive intrapulmonary hemorrhage throughout the entire upper lobe. Below this there is an arrow which points toward multiple emphysematous cysts in the middle lobe. The two lowest arrows point toward hemorrhaaic lesions which resemble infarcts along the costo-phrenic border of the lower lobe.

pleura where small blebs surrounded by a narrow zone of hemorrhage are usually visualized. The blebs are usually in about the same location as the superficial pulmonary lacerations which have been described. Emphysema, however, may be deep-seated, especially in the lower lobes, and it may be accompanied by gross hemorrhage. Multiple, spherical, air-bearing spaces from 2 mm to 5 mm in diameter are common within the lung and microscopic study discloses other smaller emphysematous areas.

Microscopic studies indicate that essentially all gross changes are due to impact. Pulmonary embolism of fatty droplets secondary to fractures is a frequent complication and may be responsible for some of the gross changes. Of still greater interest, however, are occasional cases in which embolic fragments of bone marrow containing hematopoietic cells may be found in small pulmonary arteries.

Clinical features. The lesions of traumatic pneumonosis may be responsible for sudden death or they may contribute materially to the clinical picture of concussion and "shock." When the lesions are small, there may be no signs or symptoms, and x-ray may be negative. With more extensive lesions, there may be mild pain in the chest with positive x-ray findings and physical signs of pulmonary involvement. In the most severe cases the respiratory rate is rapid. Dyspnea and cyanosis are prominent. Pain in the chest may be present but is never severe. Physical examination discloses areas of dullness with rales and, at times, signs of a pneumothorax or fluid in

Traumatic pneumonosis with no fractures, mottled density in the left upper lobe and partial right pneumothorax. In 3 weeks the lungs, except for a slight residual pneumothorax, were normal.



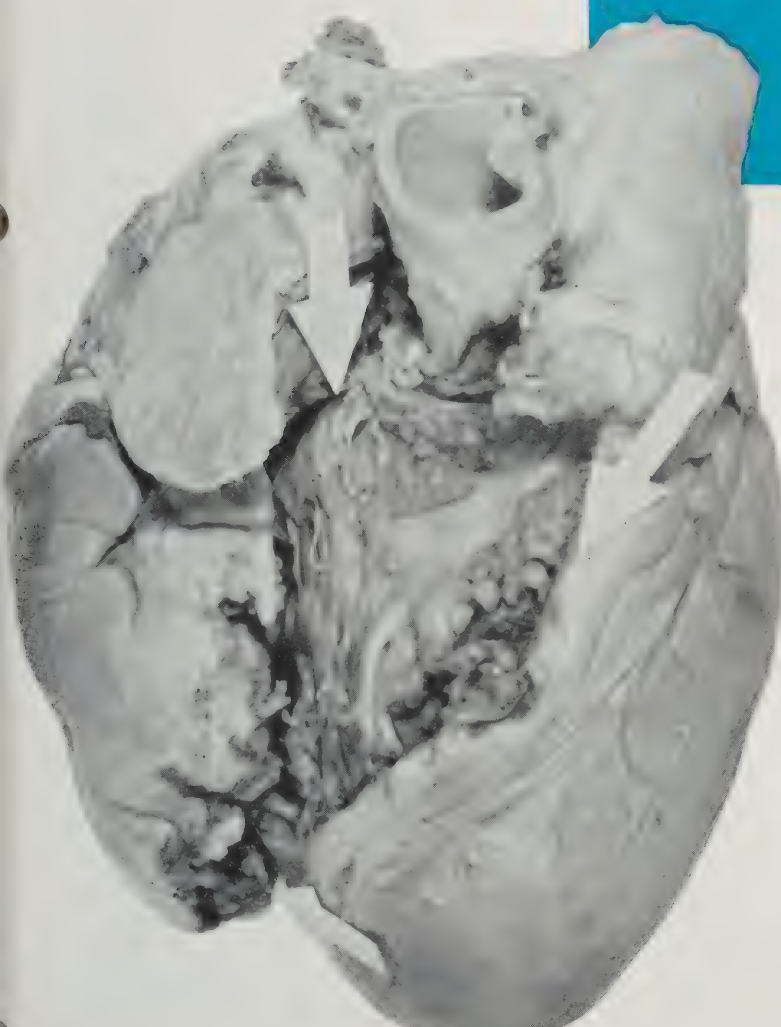
pleural cavities. In surviving cases the pneumothorax is usually unilateral and not complete. However, cases may survive for a time with a bilateral pneumothorax which is characteristically partial on each side. In these cases of trumatic pneumonosis, x-rays show mottled areas of increased density in the lungs, evidence of fluid in the pleural cavities and, occasionally, evidence of a partial unilateral or bilateral pneumothorax. The mottling of the lungs resembles pneumonic processes or zones of infarction.

Treatment. The best methods for treating cases with traumatic pneumonosis have not yet been established. It seems clear, however, that the administration of oxygen is beneficial. It is doubtful whether the administration of whole blood or plasma is of any value unless the patient is in "shock" or has lost considerable blood.

Cardiac and aortic lesions

Pathologic changes in the heart, thoracic aorta and branches of the abdominal aorta are often found in fatal cases.

The Heart. The most frequent finding when the heart is involved is a tear in the wall of the right auricle. The tear may involve nothing more than the endocardium above the annulus of the tricuspid valve but it often extends through the myocardium to provide direct communication between the lumen of the auricle and the pericardial cavity. The opening may be small but usually extends transversely from right to left across the superior wall of the auricle toward the auricular appendage. When the tear is large, the entire auricular cavity is exposed to view. In the most severe cases the laceration extends through the annulus of the tricuspid valve and downward through the myocardium of the right ventricle along the anterior border of the interventricular septum. The hemopericardium in these instances usually is not confined because a tear in the wall of the auricle often is complicated by pleuro-pericardial lacerations, usually occurring where the pericardium is reflected from the superior or inferior vena cava. This permits blood in the pericardial sac to drain into the right pleural cavity. Lesions of this type involving the myocardium may also involve leaflets of valves. In such instances lacerations have been found along the line of attachment at the bases of leaflets of the tricuspid and mitral valves. Chordae tendineae have not been involved. Cusps of the aortic and pulmonary valves remain intact. An interesting example of traumatic ectopia cordis of both pilot and co-pilot of a crashed aircraft has been described.

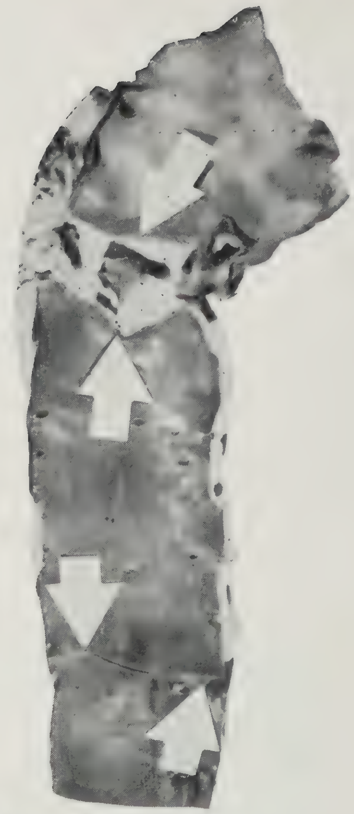


Rupture of the heart in the absence of thoracic fractures. The upper short arrow is at the lower margin of a laceration of the right auricular wall. The laceration extends, as indicated by the two lower arrows, through the right ventricular myocardium from the base to the apex of the heart.

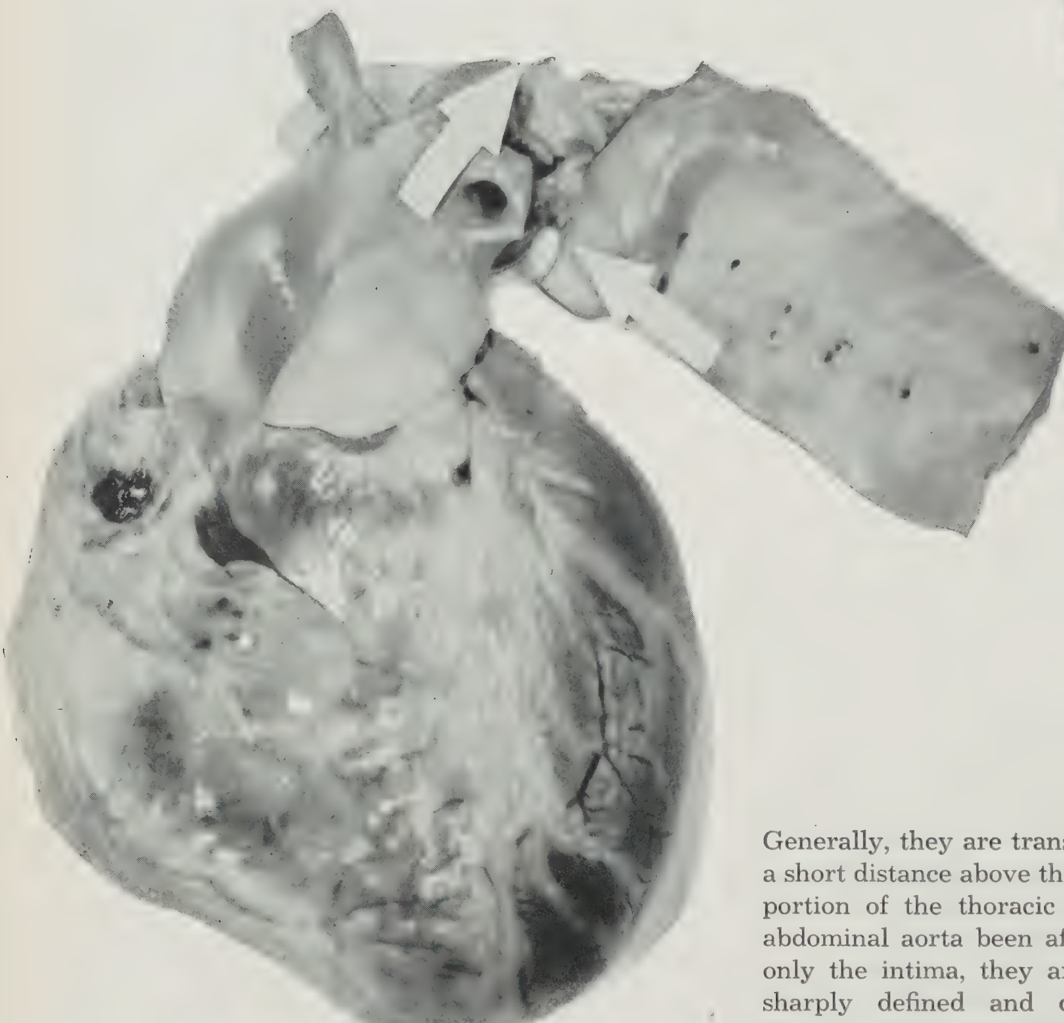
Manifestations arising from cardiac changes in surviving patients are not well known. In some cases

there are unexplained cardiac arrhythmias and precordial friction rubs which disappear as the patients recover. In one case cardiac arrhythmia and friction rub persisted until death. Necropsy disclosed hemorrhages in the heart and a hemopericardium. In another case there was a friction rub which disappeared and a hemopericardium which resolved as the patient recovered.

Aorta. In fatal cases, lacerations in the wall of the aorta are common. They are usually in the adventitia but may involve one or more of the three layers.



Transverse lacerations of the terminal arch and proximal descending segment of the thoracic aorta. The paired arrows point toward the proximal and distal margins of each laceration.

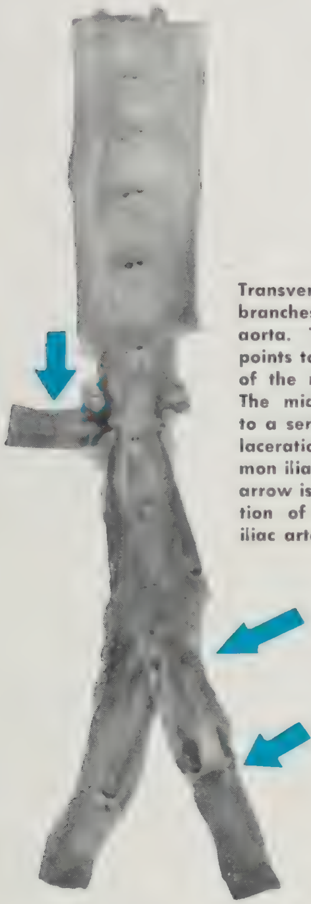


Complete transverse rupture of the aorta. The upper arrow points toward the proximal and the lower arrow toward the distal margin of the laceration. Note the hematoma in the wall of the right auricle.

Generally, they are transverse and are found either a short distance above the aortic valve or in the midportion of the thoracic aorta. In no case has the abdominal aorta been affected. When tears involve only the intima, they are usually multiple, linear, sharply defined and disposed circumferentially. When the adventitia is involved, the tears usually are irregular, being distributed along the descending portion of the thoracic aorta and accompanied by hemorrhage. When all layers of the aortic wall are involved at one point, there is a transverse lacera-

tion which may be so extensive that the vessel is separated into 2 parts. As a rule, however, less than one-fourth of the circumference of the vessel is torn. These lesions, in accordance with their locations, lead to hemorrhage into the pericardial sac, mediastinum and pleural cavities.

There is no proof that rupture of the thoracic aorta has occurred in a surviving case.



Transverse lacerations of branches of the abdominal aorta. The upper arrow points toward a laceration of the right renal artery. The middle arrow points to a series of small linear lacerations of the left common iliac artery. The lower arrow is opposite a laceration of the left external iliac artery.

Aortic branches. Ruptures of branches of the abdominal aorta have been found in several fatal cases. The lesions are of the same type as those described in the thoracic aorta. The renal arteries and the superior mesenteric artery near its origin are most often involved.

There is no proof that rupture of a branch of the abdominal aorta has occurred in a surviving case.

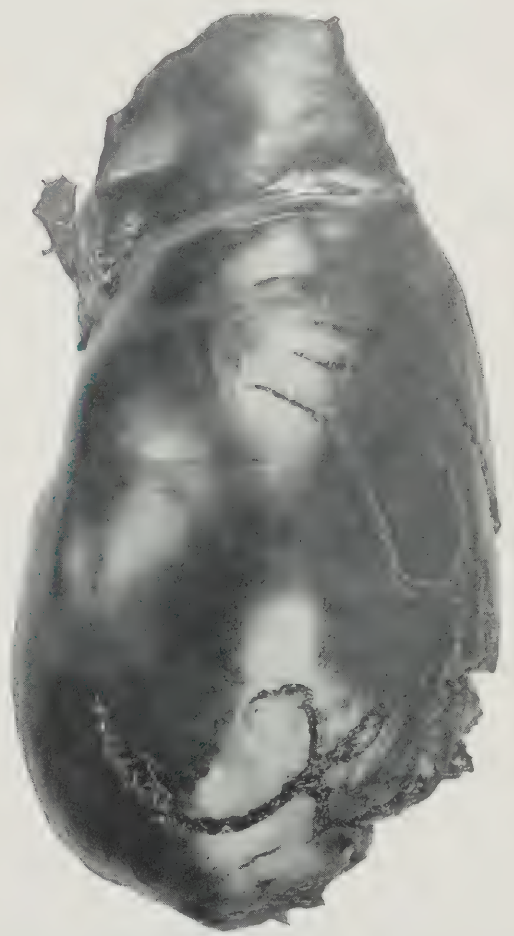
Lesions of the diaphragm

In mild cases hemorrhage into the musculature is all that is found. In more severe cases the marginal attachments of the diaphragm are lacerated. The lacerations usually occur in the posterior axillary line and are more often on the right. In the most severe cases, rents in the diaphragm are large. Projection of the right lobe of the liver, spleen, fundus of the stomach, or other abdominal viscera into the pleural cavities is the result.

There has been no proof that any case has survived with a laceration of the diaphragm. There have been surviving cases in whom persistent abnormal outlines of the diaphragm have been disclosed by x-ray examination. It is likely that minor ruptures of the diaphragm occasionally occur, and surviving cases subjected to large force may at some time in the future develop complications incidental to an undisclosed diaphragmatic rupture.

Lesions of the liver and spleen

Lacerations of the liver and spleen are frequent. The lacerations vary greatly in size, position and number. In fatal cases the liver is involved more frequently than the spleen, while in surviving cases the



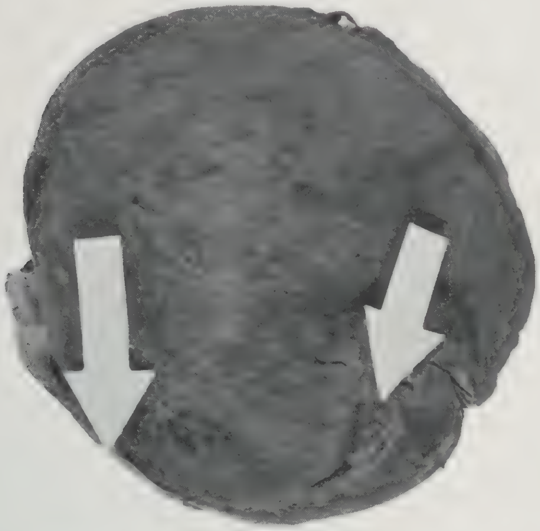
Multiple lacerations of the liver (viewed from above).

reverse is true. As a rule hepatic lacerations are peripheral, involving the capsule and subjacent parenchyma of the superior convex surface of the right lobe. Less frequently they are located in a similar position in the left lobe, and still less commonly on the inferior surface. The most obscure hepatic lacerations occur deep in the parenchyma and characteristically radiate from large hepatic veins near their terminations in the inferior vena cava. Lacerations of the diaphragm commonly accompany lacerations of the liver. Splenic lacerations usually involve the capsule and pulp. Frequently they radiate from the region of the vascular pedicle, although large lacerations of the convexity are common. In the presence of a laceration of the spleen, an adjacent laceration of the diaphragm should always be suspected. An interesting finding, as yet unexplained, is the absence of local hemorrhage in several cases with large hepatic and splenic lacerations. The pilots were killed suddenly and although there was profuse bleeding into the lungs and pleural cavities, there was no trace of blood which had escaped from wide, gaping lacerations of the liver and spleen.

It is believed that upper abdominal pain and rigidity in some surviving cases may be due to small hepatic or splenic lacerations which heal spontaneously. For example, one patient complained of pain in the left lower chest and left upper abdomen. Upper abdominal rigidity subsided but pain persisted. X-rays showed evidence of traumatic pneu-

Elevation of the left leaf of the diaphragm and increased density of traumatic origin in the left lower lobe. The ruptured spleen which elevated the diaphragm was not recognized for several months. (See next page).

monosis in the left lower lobe with elevation of the diaphragm. Three months after return to duty, he had acute upper abdominal pain. The left leaf of the diaphragm was still elevated. Surgical exploration revealed a mass bound down by adhesions in the left upper quadrant. The spleen, surrounded by old and recent hemorrhage, was separated from the adhesions and removed surgically. This case is a good example of a late complication of a ruptured spleen. The diagnosis would never have been made if exacerbation of acute symptoms, 4 months after the initial injury, had not required surgical intervention.



A spleen removed several months after traumatic rupture. The short arrow points toward a depressed healed scar. The long arrow points toward the thick scarred capsule which was torn during removal of the spleen.

Lesions of the gastrointestinal tract

Pathologic changes are found frequently in the intestine and its mesenteries. No significant lesion of the stomach or its mesentery has been observed. The root and leaves of the mesentery of the ileum have been involved in several cases.

The mesentery. The three principal lesions at the root of the mesentery are laceration, hemorrhage and arterial rupture. Lacerations are prominent in two locations, first, near the ligament of Treitz, (A in figure), and, second, near the ilercecal junction (B in figure). In the first location they are restricted to a small area. In the second location they vary from local avulsions to extensive tears which so separate the mesentery from its attachment to the posterior abdominal wall that the ileum is suspended by a narrow pedicle which includes the main trunk

COMMON INTESTINAL AND MESENTETRIC LESIONS RESULTING FROM TRAUMA IN AIRCRAFT ACCIDENTS

Laceration of root of mesentery, transverse rupture of superior mesenteric artery and avulsion of serosa of the jejunum near the ligament of Treitz.

Laceration of root of mesentery of ileum near the ileo-cecal junction.

Radial laceration of the mesentery of the ileum.

Laceration of mesentery at ileo-mesenteric junction with multiple tears in the wall of the ileum.

Laceration of mesentery of ileum with strangulation and gangrene or loops of ileum which have herniated through the mesenteric tear.

Lacerations of the ileum in the anti-mesenteric position.

of the superior mesenteric artery. Hemorrhage at the root of the mesentery is common if circulation of the blood continues after the accident. In these cases, hemorrhage always accompanies gross lacerations and blood is present in the retroperitoneal tissue and peritoneal cavity. At times hemorrhage occurs in the retroperitoneal tissues in the absence of demonstrable lacerations. Arterial lesions probably always accompany lacerations or hemorrhage at the root of the mesentery. The conspicuous lesions, however, are partial or complete transverse ruptures of the main trunk of the superior mesenteric artery. These lesions always occur in conjunction with extensive lacerations near the ligament of Treitz.

Lesions of the leaves of the mesentery of the ileum are more common than lesions of the root of the mesentery. Both types of lesions may be coexistent. The principal lesions of the leaves of the mesentery are laceration, hemorrhage and vascular rupture. One type of laceration extends radially from the ileomesenteric junction toward the root of the mesentery. The second type of laceration passes along the ileomesenteric attachment so that in severe cases a segment of ileum becomes separated from the mesentery and its blood supply (D). Hemorrhage arising from lesions of leaves of the mesentery is governed by the same rules as given for hemorrhage at the root of the mesentery. Rupture of mesenteric vessels may occur in the absence of gross lacerations. As a rule, however, a laceration is present, and the walls of vessels along its margins are torn. This is especially true when lacerations occur along ileomesenteric junctions. When lacerations are radial in distribution, larger vessels are frequently spared because the tear in the mesentery is tangent or parallel to large vascular structures.

Mesocolon. Significant lesions in the mesentery of the colon are rare. They are of the same type as those described in the leaves of the mesentery of the ileum. They are usually restricted to the mesentery of the sigmoid colon.

Intestine. The principal lesions of the wall of the intestine are laceration and hemorrhage. One type of laceration is restricted to the serosa of the ileum and is usually continuous with small tears where the peritoneum of the bowel is reflected to the ligament of Treitz (A). This type of laceration is common near the ligament of Treitz and at various points along the course of the upper ileum. At times these lacerations extend deeply into the wall of the bowel so that multiple minute perforations are produced. In more severe cases there are irregular tears in the wall of the bowel, usually associated with separation of the iliac segment from its mesentery at the ileomesenteric junction (D). Superficial serosal tears of the iliac wall are rarely found in an antimesenteric position (F). When lesions occur in this distribution, they are fairly large, irregular tears involving the entire wall. Hemorrhage arising from lesions of the ileum is absent when decelerative forces cause sudden death. In other cases, hemorrhage occurs into tissues near the lesions and into the peritoneal cavity. In still other cases hemorrhage is intramural, spreading locally throughout the mucosa and musculature. In these cases gross lacerations usually are not found.

Colon. Lesions of the wall of the colon, although infrequent, are similar to those in the ileum. They are restricted to the sigmoid colon except in rare cases. In one of these cases there was a band of dense inelastic fibrous adhesions which bound the first part of the duodenum to the hepatic flexure of the colon. The wall of the duodenum was intact but a small part of the wall of the colon had been totally avulsed at the point of attachment of the adhesions.

As complications of these varied lesions of the intestine and its mesenteries intussusception, internal herniation, strangulation of a transmesenteric hernia (E), local gangrene, hemoperitoneum and generalized peritonitis have been observed.

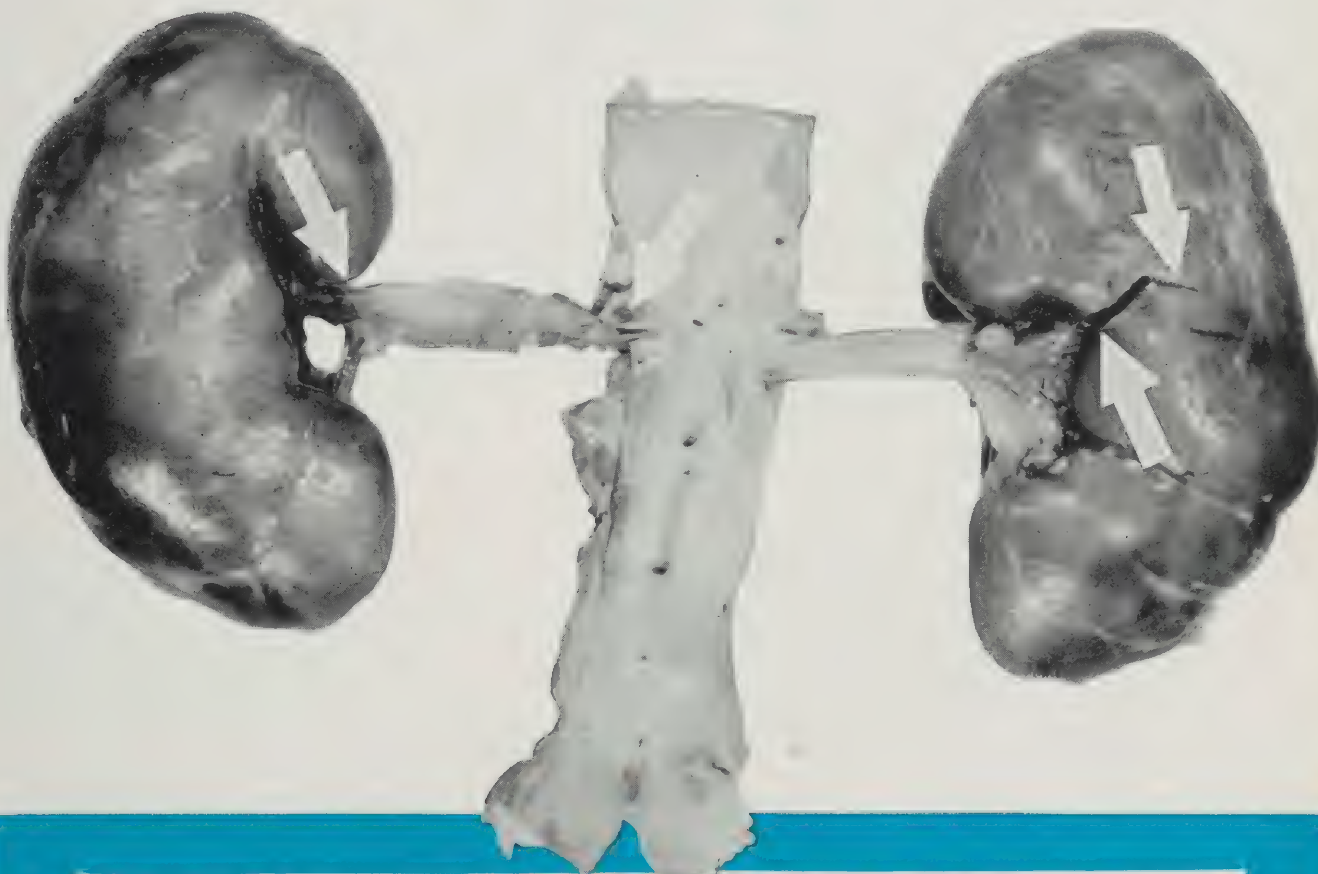
Clinical aspects. When large forces are developed in the course of an aircraft accident, lesions of the intestinal tract and its mesenteries are regularly produced. When moderate forces are developed, similar lesions may be produced and at times they are the only important lesions. If the period of unconsciousness following the accident is prolonged and shock severe, the signs and symptoms referable to an acute intra-abdominal disturbance may be obscure or regarded as clinically unimportant. Death is attributed, as a rule, to "shock," fracture of the skull or fracture of cervical vertebrae. This may be justified in some cases but when the period of unconsciousness is brief and shock is mild, signs and symptoms referable to an acute intra-abdominal condition may become clearly defined in a lucid, otherwise normal, patient. *In any case, whether the patient is conscious or not, the abdomen, especially if there is a contusion of the skin, should be examined repeatedly, keeping in mind the possibility of a lesion of the viscera.*

The onset of symptoms of internal injury may be delayed but pain and tenderness ordinarily become prominent within 8 hours. Coincident with the onset of these symptoms, local or generalized abdominal rigidity with distention develops. By this time a rising intraperitoneal fluid level due at first to

hemorrhage and later to the increasing exudate incidental to an acute peritonitis may be detected. As these signs and symptoms evolve, nausea, vomiting, hematemesis and accentuation of signs of shock indicate that the condition of the patient is rapidly becoming hopeless. By this time there will usually be a significant elevation in the temperature and the number of white blood cells but these criteria of progression of the disease are not dependable. In any event, evidence of an acute intra-abdominal condition, often obscured by progressive or delayed shock, is usually due to a lesion of the ileum and its mesentery. In the presence of this evidence, laparotomy should be done without delay even though the clinical condition of the patient attributable perhaps to "shock" or concussion might seem to be a contraindication to operation.

Lesions of the kidneys

Common injuries in fatal cases are lacerations of kidneys and renal arteries. The lacerations of the kidneys may be single or multiple. They radiate



Laceration of the left kidney and multiple delicate transverse lacerations of the intima and media of the right renal artery. All arterial lacerations lie between the two arrows which define the limits of the right renal artery.

from the hilus and usually communicate with the pelvis. Lacerations of renal arteries are circumferential in distribution and frequently accompany severe lacerations of the kidney. At times there is complete displacement of the kidney with separation of all vessels connecting it with the aorta and inferior vena cava.

Clinical features. The clinical manifestations of renal involvement are pain, albuminuria, hematuria and anuria. The only cases in which the cause of gross hematuria was established had lacerations of the kidney. Patients with albuminuria or slight hematuria ordinarily recover. All patients observed with anuria died. In two cases, anuria developed in the presence of normal blood pressures. In one case, anuria was attributed to massive retroperitoneal hemorrhage extending from above the level of the renal arteries down to the pelvis. In the other case, there were multiple small infarcts of the kidneys with unexplained degeneration of renal tubules.

Vertebral column

The vertebral column is a common site of injury. Fractures of transverse processes and bodies of

Fracture of the body of a cervical vertebra with compression and displacement but without important involvement of the spinal cord.

Fracture of the second cervical vertebra (axis) with displacement but without signs of involvement of the spinal cord.

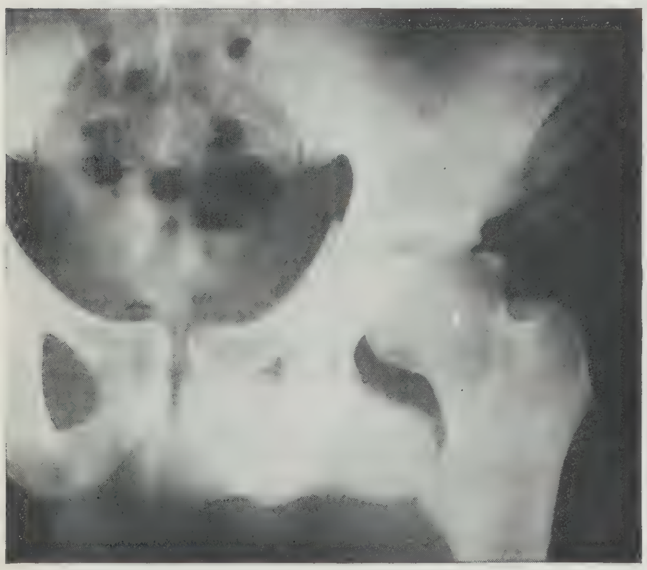
Fracture of the body of a lumbar vertebra.

Fractures of transverse processes of three lumbar vertebrae.

vertebrae are most frequent in the lower dorsal and upper lumbar regions. Cervical vertebrae are less often involved. Fractures, usually compression fractures, of vertebral bodies sometimes occur in the absence of other lesions.

Pelvis

Fractures of the pelvis are less common than fractures of the vertebral column. In general, the rami of the ischium are the usual sites and when these bones are fractured there is frequently a partial separation of the pubic bones at the symphysis. Fractures through the acetabulum occasionally occur. These are usually complicated by a fracture-dislocation of the upper articular extremity of the homolateral femur. Fractures in the region of the sacro-iliac joint are rare.



Depressed fracture of the bones forming the left acetabular fossa.

Scrotum and perineum

The perineum and scrotum are commonly lacerated when the rami of the ischium are fractured. The lacerations occur only in the presence of large forces. Contact with the seat and the action of vertical forces seem to be important causal factors although in some cases there have been reasons for suspecting that the parachute harness may have contributed to the production of the lesions.

Lower extremities

Lesions of the lower extremities are almost as common as craniofacial lesions, although the latter are usually more important. Lacerations of the thighs are usually not conspicuous. Lacerations in the region of the tibial tubercle and the knee joint are often very conspicuous. Although there may be multiple cuts and bruises along the anterior border of the tibiae, wounds around the ankle joint are usually more severe.

Femur. Fractures of the femur are usually bilateral, in the middle third of the shaft, and simple.

The usual appearance of a "seat-type" fracture in the midshaft of the femur.

Compound fracture of the tibia, just below the knee joint.

Compound fracture of the distal third of the shafts of the tibia and fibula.

Common type of fracture in the region of the ankle.

Fractures just above the knee joint or into the knee joint are perhaps second in frequency. These are usually compound. Fractures through the head and neck of the femur are the least common of all.

Reconstruction of the mode of production of femoral fractures has led to the conclusion that the fulcrums of action are the margin of the seat and the safety belt with the fracture usually occurring proximal to the point of contact of the thigh with the margin of the seat. The force required to produce these fractures is of the same magnitude as that required to deform the horizontal section of the seat. It is rare for anyone to survive forces which are sufficient to produce bilateral fractures of femoral bones.

Tibia and fibula. Common fractures of the tibia are at the junction of the middle and lower third of the shaft, and there is usually an associated fracture of the fibula at the same level. The lesions are often symmetrical and characteristically compound.

A less frequent type of fracture is in the region of the tibial tubercle. This is compound as a rule and extends into the knee joint. The lower margin of the instrument panel and the sharp margins of the shelf assembly behind the panel are the principal points of contact with aircraft structure.

Other common fractures of the lower extremities are of the Pott's type, resulting in separation of one or both malleoli and widening of the joint mortise of the ankle. Dislocation at the ankle joint and compounding of fractured malleoli are common accompanying lesions. A frequent complication which is found in the absence of a Pott's type of fracture is a dislocation or fracture of the talus of the foot.

Burns

Incidence. Burns comprise 22% of all injuries incurred in aircraft accidents. They make up 6.7% of all non-fatal injuries. In these non-fatal cases of burns 81.9% involve the head, face, hands and other parts of the extremities.

Surface area. The total surface of the body of an adult in percentage of the different parts is as follows:

Head 6%
Trunk 38%
Both upper extremities 18%; one hand 2%
Both lower extremities 38%; one foot 3%

Patients with 20% of the surface involved show a mortality of 15% to 20% and the mortality rises rapidly toward 100% when the involved area is 50% or more. The method of estimating area involved should be taught to all medical personnel and should be marked at once on the Emergency Medical Tag of each burned casualty.

Prophylaxis. The flight surgeon is responsible for the use of prophylactic measures in his squadron. These consist of wearing all possible coverings for the skin. Even the lightest cotton shirt protects against the usual flash burn seen in aircraft accidents. Shirt sleeves should be rolled down. Shorts should not be worn. Goggles, gloves, and helmets should always be used on take-offs, landings, and when fire is anticipated or encountered in flight. The oxygen mask offers additional protection of the face when available.

Objectives of treatment. The ideal objectives in the treatment of burns may be listed as:

1. Prevention of infection.
2. Relief of pain.
3. Prevention of shock.
4. Prevention of further damage to tissues by over-zealous local treatment.
5. Early restoration of function.
6. Accomplishment of best possible cosmetic result.

First-aid treatment. Relief of pain is of immediate importance. Morphine is the drug of choice and should be given in quantities sufficient to achieve results. Over-dosage must be guarded against. This happens when the patient is in shock. The drug is injected into a relatively avascular skin and subcutaneous tissue, and more is then given because the original was not absorbed.

A burn is an open wound and at the beginning every effort must be made to prevent contamination in excess of that already present. Only such clothing as is necessary to expose the burn should be cut off and there should be a minimum of handling. With the best possible technique sterile compresses, towels, sheets or clean linen, if nothing else is available, should be applied to the burned area and kept in place by snug bandages, preferably of the elastic type. The patient should be kept warm but not overheated. If more than 10% to 15% of the body area is affected, plasma should be prepared and administered as soon as possible in amounts equivalent to 100 cc for each 1% of the area involved. This estimated amount should be administered in the first 12 to 18 hours. Thereafter, the amount needed will depend upon the condition of the patient. The amount given should be recorded on the EMT.

The patient should then be moved from the scene of the accident to the aid station or other suitable location where more detailed initial treatment can be given.

Definitive care. Once the patient has arrived where aseptic precautions may be observed the treatment consists of further cleansing of skin around the wound with soap, water and 70% alcohol. Debridement should be minimal and blisters should not be ruptured. Sterile vaseline gauze with adequate padding is applied and held in place by pre-cut sterile stockinet of suitable size. Firm pressure is made on the dressing from periphery to trunk by means of elastic bandage.

During and after this treatment the circulating blood volume must be carefully checked by hematocrit and serum proteins, and plasma or whole blood given as indicated. A high protein diet (100 gms a day) and large doses of vitamin C may be helpful.

Chemotherapy may be used and of the drugs available penicillin gives the fewest complications, and probably the most protection. Parenteral use is most effective and dosage should be in the neighborhood of 100,000 units a day.

Unless there is gross evidence of infection, dressings should be undisturbed for 2 weeks. Third degree burns should be skin grafted at the earliest possible opportunity, preferably not over 3 to 4 weeks after inception of the burn.

For plastic correction of thermal scars, see standard texts.

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NOXIOUS GASES AND VAPORS IN AIRCRAFT

Contamination of the atmosphere in the cockpit of an airplane may result from the following:

Exhaust gases, gasoline vapors, hydraulic fluid vapors, coolant fluid vapors, oil fumes.

EXHAUST GASES

The composition of exhaust gas varies widely, depending largely upon the grade of aviation fuel and the fuel-air ratio at which the engine is operated. Assuming a fuel-air ratio of 0.75 for cruising and 0.095 for take-off, the following compositions, in per cent by weight are representative:

	TAKE-OFF	CRUISING
CO	8.75	3.03
CO_2	10.14	15.11
CH_4	0.31	0.24
C_4H_8	0.37	0.34
N_2	70.43	71.50
O_2	0.84	0.77
H_2	0.36	0.045
H_2O	8.80	8.80

Carbon monoxide, methane, and hydrogen result from incomplete combustion of the fuel. As the fuel-air ratio decreases and the completeness of combustion increases, the percentage of carbon dioxide in the exhaust gas rises, with a corresponding decline in the percentage of carbon monoxide. Conversely, as the mixture becomes richer, the carbon monoxide of the exhaust gas increases.

Some fuels contain xylidine. When these are burned the oxides of nitrogen also appear in the exhaust gas, in concentration depending upon the concentration of xylidine in the gasoline and the fuel-air ratio.

Aircraft vary with respect to the frequency and severity of their contamination by exhaust gases. Single-engine types with the engine directly in front of the fuselage are subject to greater contamination than are multi-engine planes with laterally situated engines. There is also evidence to indicate that liquid-cooled single-engine types are less likely to be contaminated by exhaust gas than are air-cooled radial engine airplanes.

All new aircraft models must meet rather rigid specifications for freedom from contamination by carbon monoxide before they are accepted by the AAF. However, since exhaust gases may get into the cockpit in several ways, planes which were originally free from contamination, or contained only slight amounts of carbon monoxide at the initial test, may deteriorate from wear and tear or change as a result of structural modifications introduced while in service. Periodic tests will reveal such contamination and serve as a check on the adequacy of the maintenance service.

Carbon Monoxide (CO.)

Carbon monoxide is the most important indicator of the presence of exhaust gas, both because it is the principal toxic constituent of exhaust gas and because it is most easily measured. It can be detected readily in air by the Mines Safety Appliance carbon monoxide indicator or by a colorimetric method which has recently been developed by the National Bureau of Standards. The maximum allowable concentration of carbon monoxide in AAF cockpits is 0.005%.

Tests of cabin air, however, give an indication of the conditions only at the particular moment when the air is tested. These conditions vary according to the length of time the engine has been running, the fuel-air ratio, the ventilation, and the position in cabin from which the sample is taken. From a practical standpoint, the carbon monoxide content of the pilot's blood is a more important consideration, for this represents the cumulative effect of the gas to which he has been exposed. Blood analysis can be performed with the Van Slyke Apparatus or by the micro-technique of Scholander and Roughton. In evaluating blood concentrations, it is important to consider the "normal" values, especially in smokers, in whom the control values of carbon monoxide may be as high as 7 to 8% saturation.

Causes of CO in the cockpit. Failures in the exhaust system have been responsible for several cases of seepage of carbon monoxide into the cockpit. In some, this failure has consisted of cracks in the exhaust stacks from excessive vibration. In others, the gas has gained access to the cockpit through worn packings around the collector rings. Contamination has occurred in planes which are equipped with exhaust heaters, from wear of the intensifier tube assembly, and from defects caused by enemy fire. Because of the latter possibility, pilots are advised not to use their exhaust heaters in combat. A new signal assembly, type K-1, is now installed in B-24 aircraft with heat exchanger systems. If a leak occurs, and the concentration of carbon monoxide in the cabin exceeds 0.005%, a warning light on the pilot's control panel is energized.

Carbon monoxide may also be present in turrets and near gun positions as a result of incomplete oxidation of the explosive mixtures. The firing of guns and cannons, however, has not been an important source of the gas in AAF aircraft.

Pharmacology. Carbon monoxide is a colorless gas slightly lighter than air. Since it is also odorless its presence should be suspected whenever exhaust gases are smelled. It is absorbed exclusively through the lungs, the rate of uptake depending upon the rate and depth of respiration, the concentration of carbon monoxide in the air, the duration of exposure, the blood volume and hemoglobin concentration and the degree of saturation of the blood with carbon monoxide. In an individual with a normal hemoglobin concentration of 16 grams per 100 cc, 20 volumes per cent of carbon monoxide represents complete saturation of the blood. When the blood saturation does not exceed 35%, the rate of uptake is represented by a straight line:

$$\triangle \% \text{ COHb} = K \frac{\text{total ventilation x CO conc. of air}}{\text{Blood volume}}$$

Assuming a blood volume of 6,000 cc and a respiratory rate of 20 liters per minute (moderate exercise), if the permissible blood carbon monoxide be limited to 10 per cent saturation, then:

20 parts CO per 10,000 can be breathed for 5 minutes;

15 parts CO per 10,000 can be breathed for 6½ minutes;

10 parts CO per 10,000 can be breathed for 10 minutes.

For an individual at rest (ventilation 6 liters per minute, pulse 70), the increase in percentage saturation of the blood with carbon monoxide ($\Delta\%$COHb) is given by the concentration of carbon monoxide in the inspired air (%CO) times the minutes of exposure (t) divided by 0.3, or:

$$\triangle \% \text{COHb} = \% \text{CO x } \frac{\quad}{0.3}$$

Similarly, for light activity (ventilation 9½ liters per minute, pulse 80),
divide by 0.2
for light work (ventilation 18 liters per minute, pulse 110),
divide by 0.12
for heavy work (ventilation 30 liters per minute, pulse 135),
divide by 0.085

At rest or during light activity, about 50% of the inspired carbon monoxide is taken up by the blood initially. Of the gas which actually enters the alveoli a much larger proportion, about 90%, is retained by the blood. Although carbon monoxide combines with hemoglobin less readily than does oxygen, the rate of dissociation of carboxy-hemoglobin is much slower. The affinity of human hemoglobin for carbon monoxide is 210 to 300 times its affinity for oxygen. The formation of carboxy-hemoglobin is favored by a reduction in the concentration of oxygen in the air and by an increase in the temperature or humidity. When any of these changes occurs, or the amount of physical activity is increased, the toxic effects of carbon monoxide occur more quickly.

Strictly speaking, carbon monoxide is not a poison. It acts rather as a tissue asphyxiant, accomplishing this function by a twofold action. First, by combining with the hemoglobin to the partial exclusion of oxygen, it interferes with the uptake of oxygen by the blood. Second, it causes a shift to the left of the oxygen dissociation curve of the remaining hemoglobin and also makes the curve less S-shaped and more hyperbolic (Haldane effect). Thus, hemoglobin which is partially saturated with carbon monoxide clings to its oxygen with increased tenacity, with the result that less oxygen is liberated to the tissues. Both phenomena combine to produce anoxia.

Symptoms. The structures which are most sensitive to anoxia, such as the central nervous system and the myocardium, are the first to be affected. In order of frequency, the leading symptoms of carbon monoxide intoxication are: headache, weakness, vertigo, nervousness, dyspnea, paresthesias, muscular twitchings, emotional disturbances, nausea, drowsiness, unsteady gait, neuromuscular and joint pains, tremors, muscular cramps, coughing, sweating, vomiting, insomnia, anorexia, precordial distress, vas-

omotor instability, perversion of taste and smell, impairment of speech and hearing, hoarseness, and yawning. Among the ophthalmological manifestations, after long-continued or repeated exposure, are contraction of the visual fields, amblyopia, anisocoria, retinal edema, diplopia, and neuroretinitis, which

SYMPTOMS OF VARIOUS BLOOD CONCENTRATIONS OF CO AT SEA LEVEL

% Saturation	*Symptoms*
Less than 10	None
10	No appreciable effect except shortness of breath on vigorous muscular exertion.
20	Shortness of breath, even on moderate exertion; slight headache.
30	Decided headache; fatiguability; irritability; impaired judgment.
40 to 50	Headache; confusion; collapse and fainting.
60 to 70	Unconsciousness; respiratory failure and death if exposure is prolonged
80 or more	Rapidly fatal.

(Based on data in Henderson, Y. and Haggard, H. W.: Noxious gases and the principles of respiration influencing their action, 2nd edition, 1943, Reinhold Publishing Corp., New York.)

EFFECTS OF VARIOUS CONCENTRATIONS OF CO IN AIR AT SEA LEVEL

% CO in Air	*Effects*
0.02	Headache in 2 to 3 hours.
0.04	Headache and nausea after 1 to 2 hours
0.08	Headache, dizziness, and nausea in 45 minutes; collapse and unconsciousness in 2 hours.
0.16	Headache, dizziness, and nausea in 20 minutes; unconsciousness and possibly death in 2 hours.
0.32	Headache and dizziness in 5 to 10 minutes; unconsciousness and possibly death in 30 minutes
0.64	Headache and dizziness in 1 to 2 minutes; unconsciousness and possibly death in 10 to 15 minutes.
1.28	Immediate unconsciousness and danger of death in 1 to 3 minutes.

(Based on data in Hamilton, A.: Industrial Toxicology, Harper and Bros., New York, 1934.)

may be of especial significance to flying personnel. In cases of acute poisoning, the more severe the gassing, the fewer the symptoms, since unconsciousness soon occurs. It is in those cases in which the exposure has been less severe, more protracted, and frequently recurring that the greatest individual variation in symptoms is encountered

Blood concentrations of carbon monoxide up to 10% saturation usually cause no symptoms under ordinary conditions (sea level, moderate physical activity, normal hemoglobin). With increasing blood saturation, symptoms appear, usually in the sequence shown in the first table. The approximate times required for the appearance of symptoms with exposure to varying concentrations of carbon monoxide are shown in the second table.

Altitude and Carbon Monoxide. The hazard of carbon monoxide rises sharply at altitudes above sea level. Mild degrees of anoxia caused by increasing altitude and small amounts of carbon monoxide, each of which might be harmless alone, may, when combined, cause serious impairment of efficiency as a result of the additive anoxic effects. Assuming that a minimum blood 0_2 saturation of 85% is required for the maintenance of flying efficiency, even small concentrations of carbon monoxide in the inspired air reduce the ceiling of 10,000 feet below which flights may be made without oxygen. For example, a concentration of 0.01% CO in the air, relatively safe at ground level, reduces the oxygenation of the blood by 10.5% at 10,000 feet, resulting in a dangerous state of anoxia.

Above 10,000 feet, when the demand oxygen system is used, the dangers of carbon monoxide decrease with increasing altitude, in contrast to the situation which obtains when oxygen is not used. Its beneficent effect results from the fact that as a higher percentage of oxygen is obtained from the demand system with increasing altitude, less of the atmospheric air, and consequently less carbon monoxide is obtained. Thus, while pO_2 is maintained constant because of its proportionaately larger volume in the inspired mixture, pCO declines, both because of its decreasing percentage and the increasing altitude. Above 30,000 feet, where the demand system furnishes 100% oxygen, the action of carbon monoxide is completely prevented.

Elimination. At least one-third of the carbon monoxide taken up by the blood is converted chemically to other substances in the body; the remainder is excreted as carbon monoxide in the expired air. Still, for practical purposes, the rate of elimination depends upon the respiratory volume and the percentage of oxygen in the inspired air. Breathing pure air at sea level after absorption of moderate amounts of carbon monoxide clears the blood of about one-half of the gas in one hour and elimination is practically complete within 8 hours. Increased amounts of oxygen accelerate the rate of excretion of carbon monoxide. When pure oxygen is breathed following exposure to the gas, the elimination time is reduced to an hour or less. Experiments have shown that oxygen under pressure, up to 3 atmospheres, restores consciousness rapidly to dogs and guinea pigs which have been asphyxiated by carbon monoxide.

Prophylaxis. When flying personnel suspect the presence of carbon monoxide in the plane, either because of the odor of exhaust gas or because of untoward symptoms such as headache, nausea, dizziness, or dimming of vision, they should turn off exhaust heaters if in use, and don oxygen masks with the Auto-mix of the regulator turned to the "OFF" or "100% Oxygen" position. By so doing they will assure themselves protection from carbon monoxide by excluding all cockpit air.

Treatment. Definitive treatment of carbon monoxide asphyxia by medical officers should include artificial respiration, if breathing is weak or has stopped; the administration of 100% oxygen and keeping the patient warm and at rest.

Oxides of nitrogen

The oxides of nitrogen, which are present in exhaust gas when xylidine-containing aviation fuel is burned, include:

Nitrous oxide (N_2O)	Nitrogen dioxide (NO_2)
Nitrogen oxide (NO)	Nitrogen tetroxide (N_2O_4).

These compounds are usually represented quantitatively in terms of the amount of nitrogen dioxide present. Concentrations up to 0.06% of this gas appear in exhaust mixtures when the xylidine content of the gasoline is 1%. Higher concentrations of xylidine in the fuel result in higher concentrations of the oxides in the exhaust.

A definite relationship exists between the formation of nitrogen oxides and the fuel-air ratio. In contrast to the formation of carbon monoxide, however, high fuel-air ratios result in the smallest concentrations of the oxides of nitrogen and vice versa.

Relative Importance. From the toxicologic point of view, nitrogen dioxide is the most important of the oxides of nitrogen. Nitrous oxide and nitrogen oxide are unimportant because the relatively small concentrations of these gases which are formed as a

result of the combustion of nitrogenous materials are too slight to produce their characteristic effects. Nitrous oxide, for example, exerts a narcotic action on the central nervous system only when the gas is inhaled undiluted or in high concentrations. Nitrogen oxide causes anoxia by the formation of methemoglobin and by depressing the respiratory center. Although its depressant effect in mice is more rapid and more pronounced than that of nitrous oxide, no poisonings from nitrogen oxide have been reported in the human. By contrast, many cases of poisoning from nitrogen dioxide have been observed.

Pharmacology. When nitrogen dioxide is inhaled at body temperature it is at once altered to a mixture of approximately 30% nitrogen dioxide and 70% nitrogen tetroxide. The latter reacts with water to produce nitric and nitrous acids:

$$N_2O_4 + H_2O \longrightarrow HNO_3 + HNO_2$$

These acids may account for the irritation of the mucous membranes of the eyes and upper respiratory tract which follows continued exposure to fumes of nitrogen oxides.

Symptoms. The principal symptoms of nitrogen dioxide intoxication are vertigo, headache, tightness in chest, nausea, and cough. In sufficiently high concentrations the gas produces membranous bronchitis, pulmonary edema, and death.

Prophylaxis. The oxides of nitrogen are more toxic than carbon monoxide. It is estimated that the maximum permissible concentration of nitrogen dioxide in air is 0.0025% for several hours' daily exposure at sea level. Oxides of nitrogen, on the other hand, are present in much lower concentrations in exhaust gas than is carbon monoxide. In spite of the greater toxicity of the former, therefore, it appears that if the pollution of air with CO is controlled sufficiently to prevent injurious effects protection will also be afforded against the oxides of nitrogen.

GASOLINE VAPORS

Aviation gasoline is a complex fuel consisting of a mixture of aliphatic and aromatic petroleum hydrocarbons and special additives such as tetraethyl lead and xylidine, in varying proportions. The grades of aviation gasoline used by the AAF are listed on the bottom of the page.

One gallon of gasoline, completely evaporated, will form approximately 30 cu. ft. of vapor at sea level. These vapors are heavier than air. Since they are readily absorbed by the pulmonary epithelium, their toxicity is a matter of practical importance. Untoward reactions have occurred among flying personnel who have been exposed to volatilized gasoline.

Pharmacology. The concentration of gasoline vapors which can be tolerated by man is far below

Specification	Grade	Tetraethyl Lead (cc/gal)	Xylidine (%)
AN-F-22	62	0	0
AN-F-23	73	1.0	0
AN-F-24	80	2.0	0
AN-F-25	87	4.0	0
AN-F-26	91	4.0	0
AN-F-27	98/130	4.6	0.05 to 1.0
AN-F-28	100/130	4.6	0
AN-F-33	115/145	4.6	0
PPF-44-1	100/150	4.6	3.0

that required to produce combustible or explosive mixtures with air. If the concentration of gasoline vapor in air is high, absorption by the lungs may be extremely rapid and symptoms may appear after only a few minutes of exposure. Even one-tenth of the concentration necessary to support combustion or to form an explosive mixture is harmful if inhaled for more than a short time, causing dizziness, nausea, and headache. Large amounts act as an anesthetic and cause unconsciousness.

The maximal safe concentration for exposure to vapors of ordinary gasoline is about 500 parts per million, or 0.05%. Because of its content of aromatic hydrocarbons, however, aviation gasoline is probably at least twice as toxic. Furthermore, because of the precise and frequently complicated activities which flying personnel are required to perform, even small amounts of gasoline vapors in the plane must be considered dangerous. The hazard of inhaling these vapors constitutes only a part of the total danger. The fires and explosions in flight for which they are responsible represent a many times more serious problem.

Symptoms. The symptoms and pathologic changes induced by gasoline are caused both by its irritant and its lipolytic actions. The action of the volatile aliphatic saturated hydrocarbons is essentially physicochemical. These compounds are highly soluble in fat and are absorbed particularly in the lipoid constituents of the nervous system and the blood corpuscles, where they exert their detrimental effects. Acute poisoning is marked by burning of the eyes and lachrymation, and severe cerebral symptoms, such as restlessness, excitement, disorientation; disorders of speech, vision and hearing; and convulsions, coma, and death.

Tetraethyl lead. Tetraethyl lead is fairly volatile and is also absorbed by the pulmonary epithelium. The dangers of this compound are well known. Absorption of toxic amounts is followed by a prodromal period of 2 to 8 days, after which a variety of neurologic manifestations may appear, including weakness and muscular disturbances, various sensory abnormalities, and psychic aberrations. The amount of tetraethyl lead in the various specifications of aviation fuel is in sufficiently diluted form, however, so that it is relatively free of harmful effects through the inhalation of gasoline vapors. This hazard has manifested itself only under especially bad conditions of handling the fuel, where gross spillage occurred in confined quarters.

Xylidine. Although little is known concerning the systemic effects of xylidine on man, it is highly toxic for animals. It is absorbed rapidly, both by the lungs and by the skin, and causes lachrymation, salivation, cyanosis, weakness, incoordination, spasmodic respiration, unconsciousness, convulsions, and death. It has toxic effects on the liver and produces methemoglobinemia after repeated exposure. Although frequent exposure to xylidine vapors is undoubtedly hazardous, the danger of poisoning from a single exposure to the vapors of aviation gasoline appears remote.

VAPORS OF HYDRAULIC FLUID

A small leak from a hydraulic pipe or gauge under pressure may give rise to a finely divided spray of fluid which diffuses quickly throughout the cockpit. Large leaks may result in the accumulation of a pool of liquid on the floor. In either circumstance the cockpit air soon attains a high degree of saturation with the volatile constituents of the hydraulic fluid. Their toxicity, therefore, is of interest.

Two types of hydraulic fluid are currently in use by the AAF:

1. Fluid, Hydraulic, Petroleum Base. No. AN-VV-O-366.

2. Fluid, Hydraulic, Castor Oil Base, AAF Spec, No. 3586.

These fluids are used for the aircraft hydraulic system, the gear shock struts, the auto pilot, and the shimmy damper. Technical Order No. 06-1-2, dated 10 May 1944, prescribes the proper fluid for the various reservoirs in each aircraft model. In several models both fluids are used, in different parts of the same plane. Generally speaking, however, the petroleum base fluid is used in combat airplanes (except P-40 series): fighters, attacks, bombers, and multi-engine cargo airplanes; the castor oil base fluid is used in the P-40, most trainers, single-engine cargo airplanes, and liaison types.

Pharmacology. Important differences exist between the two types of hydraulic fluid with respect to the toxicity of their constituents. Fluid No. AN-VV-0-366 consists essentially of a mineral oil base plus a viscosity index polymer. Both of these substances are of relatively low volatility and their vapors possess only a low toxicity. Fluid No. 3586, on the other hand, contains, in addition to a castor oil base, diacetone, butyl cellosolve, ethylene and propylene glycol, and octyl and isoamyl alcohols, in varying proportions. The volatile constituents, especially butyl cellosolve, the glycol derivatives,

and the alcohols, are toxic when inhaled. The alcohols, for example, are about 12 times as potent a narcotic as ethyl alcohol, and in addition, cause considerable irritation of the eyes and respiratory tract, as well as headache and vertigo. The toxic effects of butyl cellosolve vapors also include irritation of the eyes and respiratory tract, headache, vertigo, and impairment of judgment and vision. Experimental animals have been killed within a few hours by a single exposure to air containing 3 mgm. per liter (about 700 parts per million) of butyl cellosolve.

The toxic effects from inhaling the vapors of this hydraulic fluid are accentuated by increasing temperature or altitude, which serve to increase the concentration of the vapors.

In addition to its hazards of greater toxicity, hydraulic fluid No. 3586 (castor oil base) has a significantly lower flash point (115°-140°F) than does fluid No. AN-VV-O-366 (200°F). This difference, coupled with the higher volatility of the former, causes it to be ignited more easily and to propagate its flames more rapidly.

COOLANT FLUID VAPORS

Coolant fluid, for use in liquid-cooled engines, consists of ethylene glycol diluted with varying amounts of water up to 80%, according to the specific aircraft type. A small quantity of an inhibitor, designated as NaMBT, is present in the ratio of about 1 to 2,000.

Ethylene glycol is toxic when ingested. However, although fairly volatile, it does not exert any important toxic effects through inhalation of its vapors. Even after continued exposure to ethylene glycol vapors over a period of several months, no deleterious effects result, except moderate irritation of the respiratory passages. No instances of intoxication from coolant fluid vapors in flight have been reported.

Breaks in coolant lines frequently result in smoke in the cockpit, either from overheating or from the fluid itself. Smoke in the cockpit is always a matter of grave concern among pilots. It is not surprising, therefore, that in several instances pilots have abandoned their planes because of coolant line leaks. The flash point of ethylene glycol is 117°F. Yet the fire hazard from escaping coolant fluid is not great, especially since the ethylene glycol has been diluted.

OIL FUMES

The oil hose connections in airplanes consist of various types of adjustable clamps, in contrast to the pressure type connections used in the hydraulic system. Hose clamps occasionally break or come loose. When oil escapes on to hot engine parts, smoke is often formed and finds its way into the cockpit. Armstrong has mentioned several cases in which hot fumes were breathed during flight, and noted that the symptoms were similar to those of carbon monoxide poisoning, including headache, nausea, and sometimes vomiting, in addition to irritation of the eyes and upper respiratory passages. The specific chemical compounds responsible for these symptoms are not clearly defined, but they probably include methyl and ethyl aldehyde, acrolein, and para formaldehyde, which are the principal breakdown products of lubricating oil.

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ANXIETY REACTIONS IN AIRMEN
(OPERATIONAL FATIGUE)

General

The term fatigue is a difficult term to define. From a strictly physiological point of view, fatigue results from the production of certain metabolites. However, all physicians realize that one may become mentally fatigued and fatigued as the result of extreme emotional tensions. Therefore, fatigue has at least three components: physical, mental and emotional. Each of these is probably of equal importance in producing the total picture of fatigue and each contributes to the intensity of the other two.

Both physical and mental fatigue may be objectively measured within certain limits. On the other hand, the sensations of emotional fatigue are subjective, and there are no convenient ways to measure them. This accounts for the fact that the role of emotional fatigue is less appreciated and understood than the others.

The term "operational fatigue," which is of fairly recent origin, has been loosely used to cover a wide variety of conditions. Other terms which have been similarly used are flying fatigue, aeroneurosis, aeroasthenia, combat fatigue and staleness. Most of this terminology has arisen from an effort to coin new names for old friends, namely, the various psychosomatic, neurotic and psychoneurotic reactions. Further, it has been an attempt to speak of these reactions solely in environmental terms. There are some advantages to each method. It is important that all concerned be fully aware of what is meant with either terminology. It might be pointed out that fairly recently all of the foregoing terms have again been replaced by the term "anxiety reaction." This term departs from the strict environmental concept almost for the first time and indicates the basis for the syndome.

All of the conditions described under the various synonyms listed above can best be defined as a syndrome having physical, mental and emotional symptoms developing in normal and predisposed subjects undergoing the stress of flying and particularly operational flying. In the previously normal individual they may be considered as occupational diseases, whereas in the predisposed or neurotic individual flying acts as a trigger mechanism to bring out a previously dormant neurosis.

Etiology

Flying stress. It is with reference to the etiological factors of operational fatigue that the British first coined the term "flying stress." This term has also been misused by the Americans as a diagnosis. As intended to be used by the British, flying stress implies what happens *to* a flyer and not what happens *in*

him. Every flyer experiences a certain amount of physical exertion, anoxia, bad flying weather, etc. In addition to these, some flyers experience a certain amount of family difficulties, loss of friends in combat and accidents, minor and major aircraft accidents and enemy action on and off the ground. The total of all of these factors constitutes the flying stress in a given case. The *reaction* to these factors may be "operational fatigue."

Identification and displacement. The mechanisms which are most important in the production of "operational fatigue" are those of identification and displacement. By means of the first the flyer identifies himself with a friend or associate who has been killed in an aircraft accident or in combat, and eventually may convince himself that he too should be dead. By means of the second mechanism the flyer transfers the anxiety which he has, arising from any cause, to some other situation so that it manifests itself either as a phobic reaction or as various psychosomatic symptoms.

A distinction was formerly made between "operational fatigue" and "flying fatigue," the premises being that the first occurs only under operational conditions and the second occurs in non-operational flying. This is a similar argument to that which prevails concerning the distinction between the neuroses of civilian life and the "war neuroses." Any distinction which can be made in either case must be based upon the quantity of the reaction shown and the quantitative characteristics of the stresses undergone. The opportunity for traumatic psychological experiences is greatly increased and intensified under operational conditions. However, so far as a given personality is concerned, it probably makes relatively little difference whether the individual sees his best friend shot down in combat or whether he sees him spin in and burn on a training field. Similarly, it makes relatively little difference whether the pilot develops a sense of guilt because he is the only survivor of a ditching operation in the English channel, or whether he develops a sense of guilt because he is the only survivor of a crash on a mountain-side in the continental United States.

Environment. The nature of the flyer's work is such that he must maintain a high state of tension at all times or he does not long survive. In addition to this, his work is carried out in an environment which is essentially alien to man. This logically increases his tension and anxiety. An important factor to be considered is that the flyer's work is such that he does not have a normal outlet for his increased and accumulated tensions. Thus, as he is subjected to one traumatic incident after another, he is setting the stage for eventual neurotic expressions of the unreleased energies. These expressions may come as the result of either ordinary stresses indefinitely continued, or as the result of more severe and overwhelming psychological insults which may be superimposed.

Prodromes

Insomnia. Flyers in whom the stage is being set for the development of operational fatigue usually go through a series of warning, or prodromal symptoms before the full-blown syndrome is presented. This is fortunate since the detection of the condition in these prodromal periods is of paramount importance from the viewpoint of successful treatment. Usually, the first such warning symptom is disturbance of sleep. Quiet, immobility and the dark lessen the individual's hold on reality and permit disturbing memories and fantasies to intrude on consciousness. Consequently, the individual experiences difficulty in going to sleep, he dozes off to awaken with a start and repeats this form of troubled sleep with reawakening if sleep is finally attained.

Dreams. Shortly after this disturbance has begun the patient begins to have terrifying dreams of which he is often the central figure and which involve injury or death to him. Thus, the flyer dreams of mid-air collisions, of stalling out on the first turn, of catching on fire, of spinning in, etc. Another form of disturbing dream which is common and which is not mentioned frequently in the literature is that of being unable to land. Many flyers in the initial stages of this reaction are disturbed throughout the night by dreams in which they are continually and unsuccessfuly trying to get their airplane on the ground. These dreams may be sufficiently disturbing to the patient to cause him to awaken, in which case he experiences the type of difficulty described in returning to sleep.

Physical fatigue. Actual physical fatigue which has contributed to this reaction in the first place is increased by the severe disturbances of sleep. Loss of weight and numerous psychosomatic symptoms make their appearance also.

Startle reactions. The next manifestation is "startle states" occurring in the daytime. This is the result of a half dissociation of consciousness occurring because of the patients' loss of sleep and fatigue. This results in a response of momentary panic at sudden noises or movements.

Change in personality. As a result of this chain of circumstances the patient becomes introspective. He realizes the changes that are taking place but cannot assign a cause to them. He imagines himself as different from the others in his environment and usually thinks of this difference in terms of inadequacy and inferiority. This frequently produces marked feelings of guilt. The patient may respond to this in one or both of two ways. He may develop and manifest marked irritability in an effort to counter-attack his hostile, threatening environment. He may also develop a deep depression of mood as he is overwhelmed by his feelings of guilt and inadequacy. The facies of such a patient have been described by Hastings et al as having a "hunted look." Regardless of what specific form the patient's reaction takes at this point he can be generally described as undergoing a change in personality. The nature of this change is quite variable, but in general usually takes a somewhat opposite form to the patient's usual personality. The introvert becomes extroverted, the extrovert becomes introverted, etc.

Symptoms

The patient who has experienced the cycle of events described above is in an optimum state for some sudden stress, or a continuation of existing stresses, to upset his precarious equilibrium. If the patient is predisposed, the latent neurosis from which he suffers may simply be lighted up. If he is not predisposed he may suffer an acute neurotic disturbance which on the surface may present a picture almost identical with the psychoneurosis. The differentiation rests upon the time of occurrence of the causative factors and on the acuteness and quantity of the reaction.

Exhaustion. It is important to bear in mind that the next step in this chain of events may present itself as an overwhelming exhaustion. It is difficult to draw the line distinctly between a neurosis and a severe exhaustion, as each may represent a physiological and psychological inhibition. However, in those cases in which a simple physiological exhaustion exists without neurotic concomitants, the patient responds readily to rest. In those cases in which the reaction has progressed beyond that point rest alone does not benefit the patient and in fact he cannot rest without sedation even if given an opportunity to do so.

Anxiety reaction. The most common type of disturbance occurring in these patients is the acute anxiety reaction. This reaction may be masked by a reactive depression which may be so severe as to suggest that one is dealing with a true depression. A few such patients may show the various manifestations of conversion hysteria. Fortunately, most cases of this kind are recognized in the "warning stage" and consequently present the early picture of exhaustion. This probably explains the emphasis which has been placed upon the word fatigue in this connection. It is not intended to minimize in any way the actual physiological fatigue associated with operational flying and all other types of flying. It must be pointed out, however, that fatigue contributes to the individual's overall inability to cope with his environment.

Related syndromes

It must be recognized that all other types of psychiatric and psychological disturbances may occur in flying personnel as well as the one just described. There are at least three other types of psychological problems which are of importance to the flight surgeon.

First of all, there is the flyer who after one or two combat missions, or before he reaches the staging area, or when he is assigned to transition training, voluntarily and apparently on a very conscious level, refuses to fly. Those who fall in this group even in combat situation are small in number. The majority are relatively mature and of good judgment and from one viewpoint display a considerable amount of courage in announcing their decision. The consciousness of motivation in such cases may be more apparent than real since the mechanism of displacement operates here. From a military and administrative point of view, it is desirable that they should be considered as consciously motivated and made the subject of administrative action and disposition. This decision should not be made, however, upon the refusal to fly per se. Many individuals with severe and undoubted anxiety reactions will also refuse to fly if pressed. It is those who announce this decision in the absence of other evidence of emotional disturbance who should be so considered.

Secondly, there is the flyer who after approximately the same amount and type of flying experience as the first group develops symptoms which may be thought of as conversion phenomena. In a majority of cases these symptoms are referable to the gastrointestinal tract, although other somatic systems may be involved, and are in themselves sufficient to incapacitate the individual for flying. Some psychosomaticists might quarrel as to whether

these symptoms are actually conversion phenomena, but they are most easily thought of in that light.

Thirdly, there is the flyer who after a relatively short time of either operational or training flying begins to manifest symptoms of a neurasthenic type in which he employs the mechanism of displacement. Often such an individual may engage in half the required number of missions or he may instruct for several months before he becomes a problem. This freedom from symptoms is due in part to the protection which he enjoys by reason of his own ignorance of the dangers of his environment. It is also probably due to the fact that the personality is not so infantile and dependent as that of the preceding type. This man's symptoms are not incapacitating as a rule but they are a source of worry and concern. This man is not "afraid to fly"' but he feels that he should not do so until his symptoms have been alleviated. Quite frequently, these symptoms may take the form of exaggeration of actual organic difficulties. That is, the mild sinusitis becomes worse, the inability to ventilate the ears increases, etc. In common with the two preceding types, these individuals are the ones who are predisposed to psychoneurotic reactions.

Pathogenesis of anxiety reactions

Any of the foregoing types of reaction may be the result of the cumulative stresses of flying acting upon the individual personality. These cumulative stresses may vary from flights in bad weather, through aircraft accidents, mechanical failures and missions in which members of the crew are killed or injured by enemy action. The average flyer erects a system of defenses against the anxiety produced by these stresses. It is when this system of defenses begins to fail that disaster may occur.

The average flyer enters flying with the outspoken conviction that it is not a dangerous profession. As time goes on, evidence to the contrary is presented to him, and he next expresses himself by saying, "It won't happen to me." As further time elapses, and as evidence continues to be presented depending upon the number of traumatic experiences undergone he may eventually develop a fatalistic attitude in which he says, "It will happen to me, it's only a matter of time." As still more time elapses, the fact that it does not happen, in itself, becomes as disturbing as would the certain knowledge that death would occur at a certain time. When the individual has reached this frame of mind he takes off on every flight with the expectation of disaster. If nothing disastrous occurs he eventually experiences a feeling of disappointment and guilt which may lead him to become careless and to seemingly court death. An individual who is in this mental state is an optimum subject for the precipitation of an acute neurotic reaction.

Prophylaxis

The most important function which the flight surgeon has in connection with operational fatigue is its prophylaxis. In fact from one point of view this is the only function of the average flight surgeon in this connection. The actual treatment of fully developed operational fatigue, which constitutes a neurosis, is a matter for the trained and competent psychiatrist. A neurosis once fully developed is not cured by the institution of measures which might at its inception have been prophylactic.

The prophylaxis of psychological and psychiatric disturbances in those individuals who have been described as predisposed would of necessity depend upon perfect selection. Such selection is not possible and it might be argued that it would be too costly even if it were. However, the observance of certain principles of prophylaxis will reduce the incidence of unfavorable reactions even in the predisposed and will markedly reduce them in those that are not predisposed. It is important that the flight surgeon should realize that every member of the air crew, as well as the pilot, is subject to these reactions. There has been an unfortunate tendency for some flight surgeons to neglect their enlisted personnel in this respect. The following are prophylactic principles to be observed:

1. It is mandatory that the flight surgeon know the characteristics of his personnel so intimately that he is able to detect early personality changes. This may be facilitated by keeping a "secret" card system of "personality profiles."

2. It is likewise essential that early incipient cases, recognized as above, be removed from their organization as early as possible after the squadron surgeon is convinced that all his own efforts are to no avail. In common with other types of neurotic disturbances these reactions are to be thought of as infectious in nature. Therefore, to allow such a case to remain in the organization is detrimental to other personnel as well as to the individual himself.

3. In learning to know his personnel intimately the flight surgeon must not allow the patient-physician relationship to be destroyed. "Familiarity breeds contempt" and if the flight surgeon permits this type of familiarity he may be known as a good fellow but

not as a physician to turn to when in distress.

4. The proper relationship between the flight surgeon and the unit commander must be established. The unit commander can supply many valuable observations concerning flying proficiency, changes in attitude, etc., to the flight surgeon. Also, if this relationship is properly established the flight surgeon can exert considerable influence on policy, etc., through the commanding officer. Here, again, it is important that the flight surgeon not identify himself with command and lose his status as a doctor.

5. All that is possible should be done to effect favorable changes in the flyer's ground environment. Comfortable living quarters, proper diet, rest, relaxation, etc., go a long way to compensate for other unfavorable factors which cannot be altered at will.

6. Organized recreational activities are important as an outlet for the unreleased tensions of the flyer. Planned activities of this sort must be varied so that many different types of personality find an adequate outlet.

7. Every operational flying organization should have a plan of regular relief from flying duty. This applies not only with respect to total number of missions, etc., to be performed, but to short holidays during the tour. This, together with adequate replacements, does more than anything to establish an element of hope for the future.

8. Flyers who have suffered particularly harrowing experiences with obvious bad effect should be protected for the first few hours following with heavy sedation. A disturbing incident that occurred only 18 hours ago seems much more remote if the interval has been occupied with undisturbed sleep. The barbiturates are the drugs of choice here and the dosage should be enough to insure undisturbed sleep in the given individual.

9. Psychotherapy of a simple type is of immense value prophylactically. It requires that the flight surgeon should be able to listen to his personnel as they unburden their fears and troubles. He must be able to do this without acting as a judge and without identifying himself with the patient and hence with his suffering. This gives an opportunity for mental catharsis and consequent emotional release. Reassurance is inherent in this situation and may be reenforced with appropriate calm remarks.

10. The greatest source of strength and protection which the given individual has in the combat situation is identification with the group to which he belongs. Such identification is made more easily by some than by others but it is always dependent upon the leader of the group and his qualities of leadership. The leadership of a military organization is not a medical problem but the flight surgeon may be in a position to influence and improve the leadership of his organization. A successful leader must be able to formulate a plan of action and have it carried out successfully. He must make his plan understandable to those that are being led and he must allow them to see factual evidence of the results of its success. He must also impart to them the belief that the objective to be attained through such successful planning is one in which they share an equal interest with him and which is worthwhile. Above all he must be fair and just in every aspect of his dealings with his group. Unfair treatment of one member of the group is the initial step in its dissolution. Perhaps here the flight surgeon may be of most value by wise counsel. It is upon the foregoing principle that morale is built and high morale is the single factor of greatest value in the prophylaxis of anxiety reactions in airmen.

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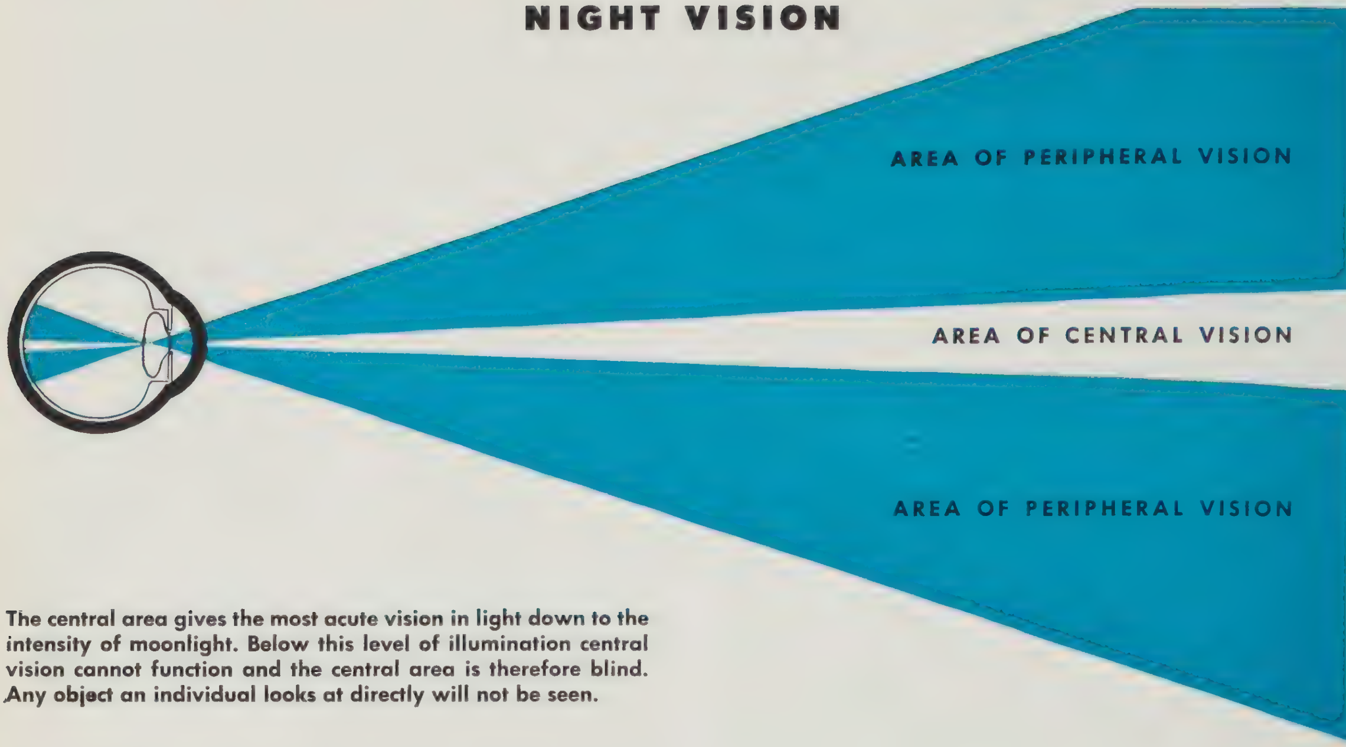
NIGHT VISION



The central area gives the most acute vision in light down to the intensity of moonlight. Below this level of illumination central vision cannot function and the central area is therefore blind. Any object an individual looks at directly will not be seen.

There are two types of sensory end organs in the retina—the rods and the cones. According to the widely accepted duplicity theory of vision, the rods are responsible for vision at very dim levels of illumination (so-called *scotopic* vision) while the cones function at the higher illumination levels (*photopic* vision). The cones alone are responsible for color vision. There is a common misconception that the rods are used only at night and the cones only during the day. The cones, as will be pointed out later, function at all levels of illumination down to their threshold. The same is true of the rods. Below the intensity of moonlight (the cone threshold) the cones cease to function and the rods alone are of value to an individual under these circumstances. Both rods and cones function at all levels of illumination above their thresholds which means that both function during the day and in the early evening.

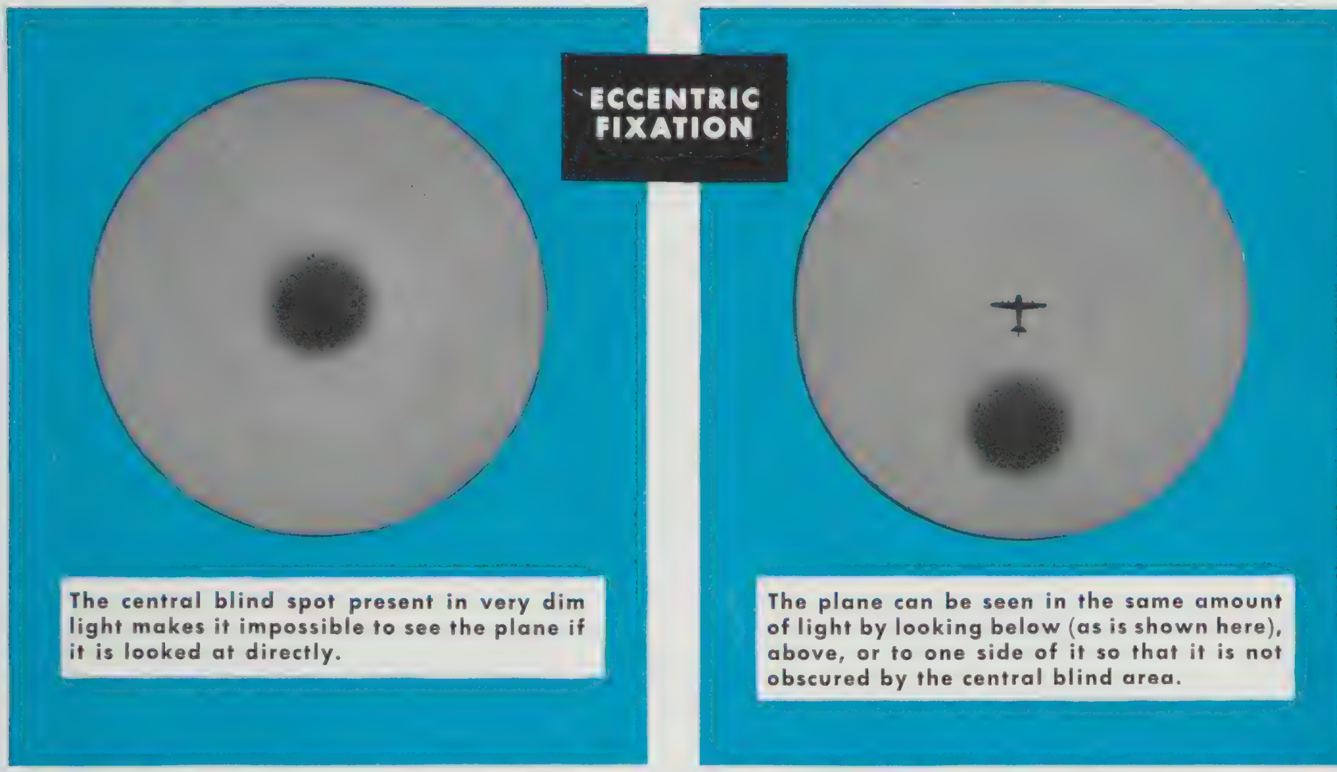
Thresholds

The dimmest light in which the rods can function is about 1/1,000,000th of a foot candle, equivalent to 1/100 of starlight. This is the *rod threshold.* The dimmest light in which the cones can function is about 1/1000th of a foot candle equivalent to moonlight. This is the *cone threshold.* A white light which can just barely be seen by the rods must be increased in brightness 100 to 1000 times before it becomes visible to the cones.

"Eccentric" fixation

The portion of the retina responsible for keenest visual acuity is the fovea which corresponds to the center of the visual field, and which is used constantly to fixate objects. The fovea is composed entirely of cones. This means that at levels of illumination below that of moonlight a blind spot develops in the center of the visual field.

Rods begin to appear in the retina at a point 1° from the fovea and gradually increase in number, finally reaching their maximum concentration at a point some 20° from the fovea. Since the rods have a much lower threshold than the cones they are therefore much more sensitive to light, an individual attempting to see an illumination dimmer than moonlight has to depend entirely on his rods. To utilize the rods under such circumstances, the individual must look slightly to one side of any object which he wishes to see. This is known as eccentric fixation. Proper indoctrination is therefore essential for maximum use of vision at night. Men are taught to look from 4° to 12° above, below, or to either side of a night target, and to employ a roving gaze. Training and repeated practice is necessary in this maneuver if the flyer is to utilize his visual powers to their fullest extent during operations at night.

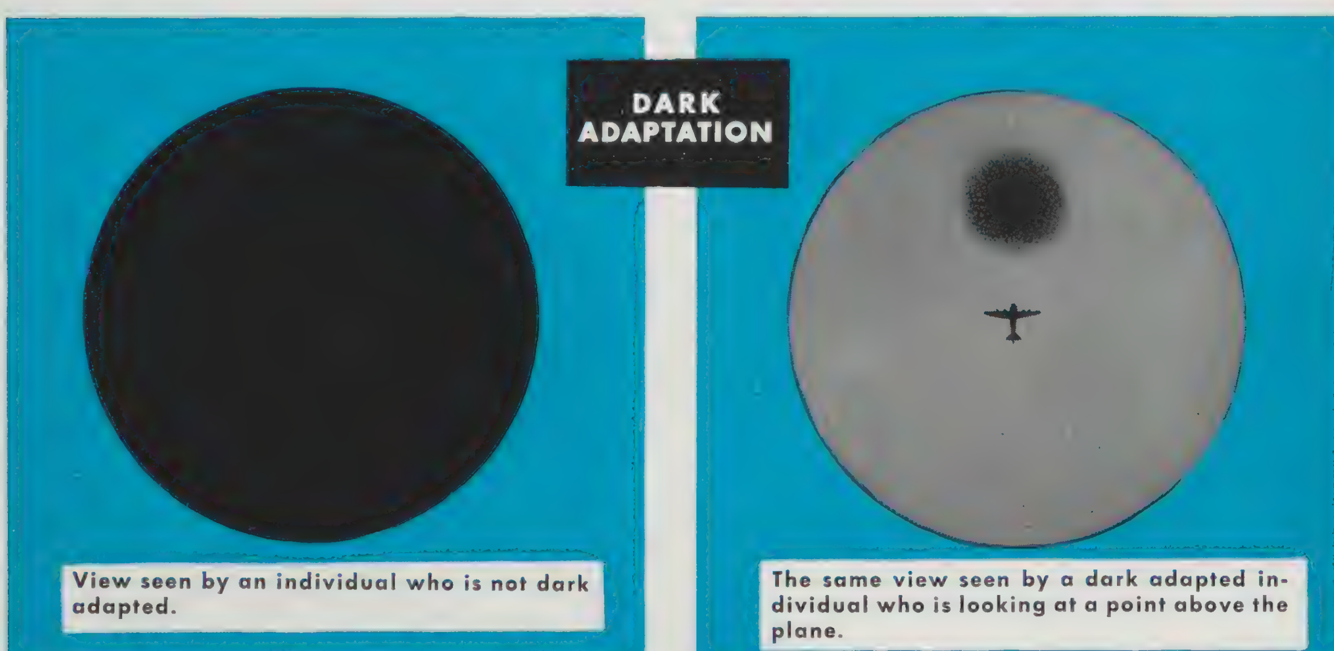


The central blind spot present in very dim light makes it impossible to see the plane if it is looked at directly.

The plane can be seen in the same amount of light by looking below (as is shown here), above, or to one side of it so that it is not obscured by the central blind area.

Dark adaptation.

Both the rods and cones contain photochemical substances which are bleached on exposure to light. This process of bleaching is thought to initiate visual impulses in the retina. The photochemical substance in the rods is visual purple or rhodopsin; in the cones it is visual violet or iodopsin. These substances are broken down or bleached by light and are rebuilt in the darkness. Dark adaptation is the accumulation of these substances in the rods and cones during periods when little or no light enters the eye. The rods and cones differ in their rate of dark adaptation, the rods requiring some 30 minutes in absolute dark-



View seen by an individual who is not dark adapted.

The same view seen by a dark adapted individual who is looking at a point above the plane.

ness to attain their maximum sensitivity after exposure to bright light, while the cones attain maximum sensitivity in about 8 minutes. The amount of light energy absorbed by visual purple determines the extent to which it is bleached. An intense light will bleach it fairly rapidly and completely while a dim light will bleach it to only a small extent and slowly. In the light adapted retina, sensitivity to light is diminished, for part of the visual purple is bleached and hence insensitive.

Photochromatic interval

Visual purple does not absorb light of a wave length greater than 6,000 Angstrom units (the red portion of the visible spectrum). The rods contain visual purple and hence the rods are almost completely insensitive to red lights. This is not true of the cones. This fact is easily demonstrated. If the intensity of a red light is slowly decreased until the cone threshold is reached, not only the color red but the light itself will disappear. If the same procedure is repeated with any color except red, e.g., violet light, the violet color will disappear at the cone threshold, but the light will still be perceived by the rods as colorless, or dim white, light. If the intensity is further decreased until the rod threshold is reached, the light will disappear entirely. The difference between the level of illumination at which the color of a light disappears (the cone threshold) and that at which the light itself disappears (the rod threshold) is known as the *photochromatic interval.* There is a photochromatic interval for every color of the spectrum except red.

Testing of night vision

There are 3 night vision tests in use in the AAF at present: (1) The AAF Eastman Night Vision Tester, (2) The SAM Portable Night Vision Tester, and (3) The Hecht-Shlaer Adaptometer, Model No. 3.

All provide a test object whose position must be correctly recognized, and a range of illumination from just below the cone threshold to just above the rod threshold.

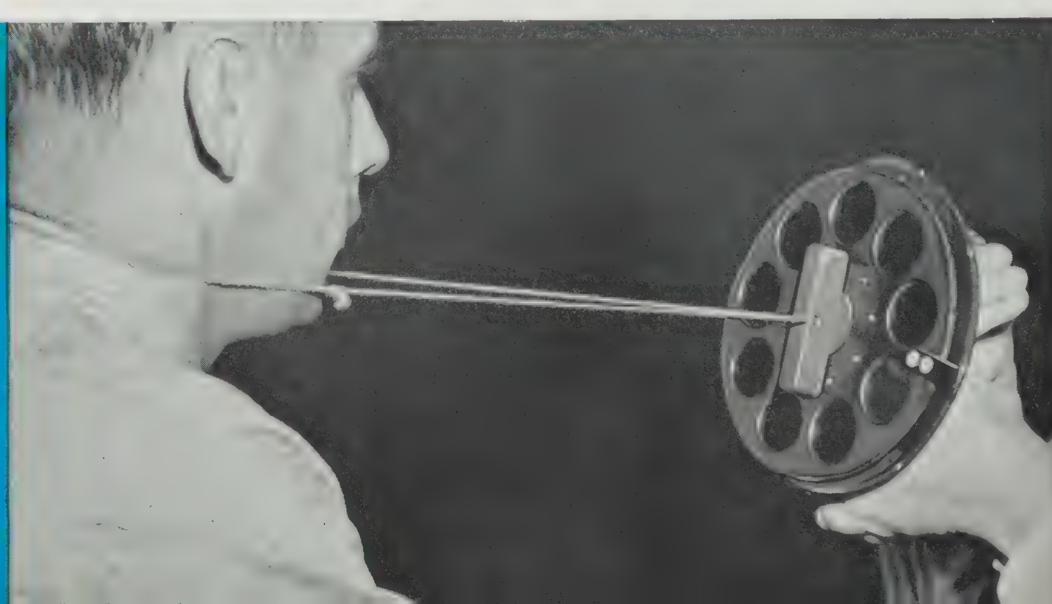
Practical problems in night vision

Contrast discrimination. Objects are seen at night only by being either lighter or darker than their backgrounds. These contrast differences are reduced by light reflected from windshield or goggles, by fog or haze, and by scratched or dirty windshield or goggles. Any transparent medium through which the flyer must look should therefore be spotlessly clean for night operations. Contrast differences are used by pilots to aid in the discovery of enemy planes while hiding their own ships. Hence when flying over dark areas, such as land, they should fly below the enemy; when flying over white clouds, desert, moonlit water, or snow, they should fly above the enemy.

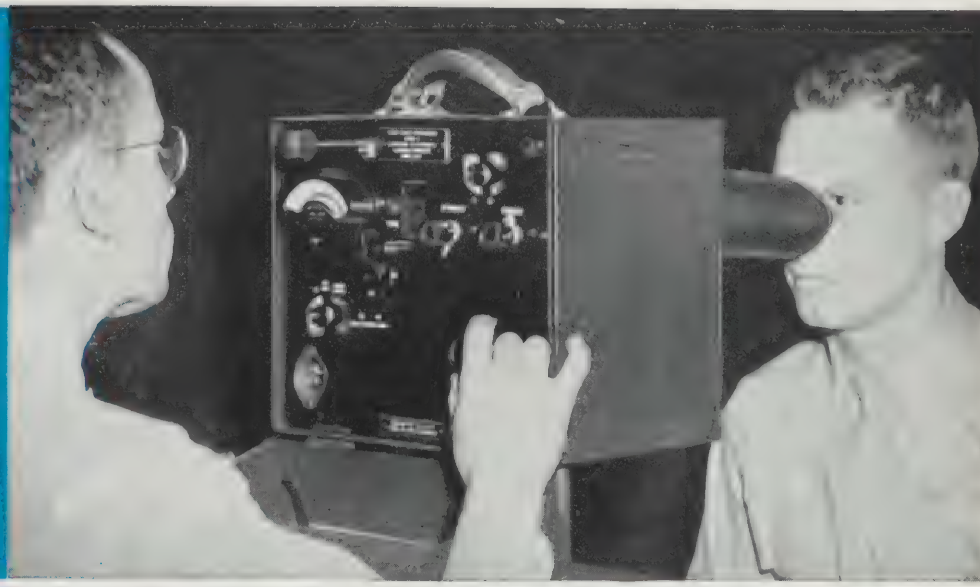
Under conditions of low illumination additional aid may be obtained by following enemy planes either from above or below rather than from directly behind. The retinal image is much larger from the former positions than from the latter and there is less likelihood of losing the enemy in the darkness.

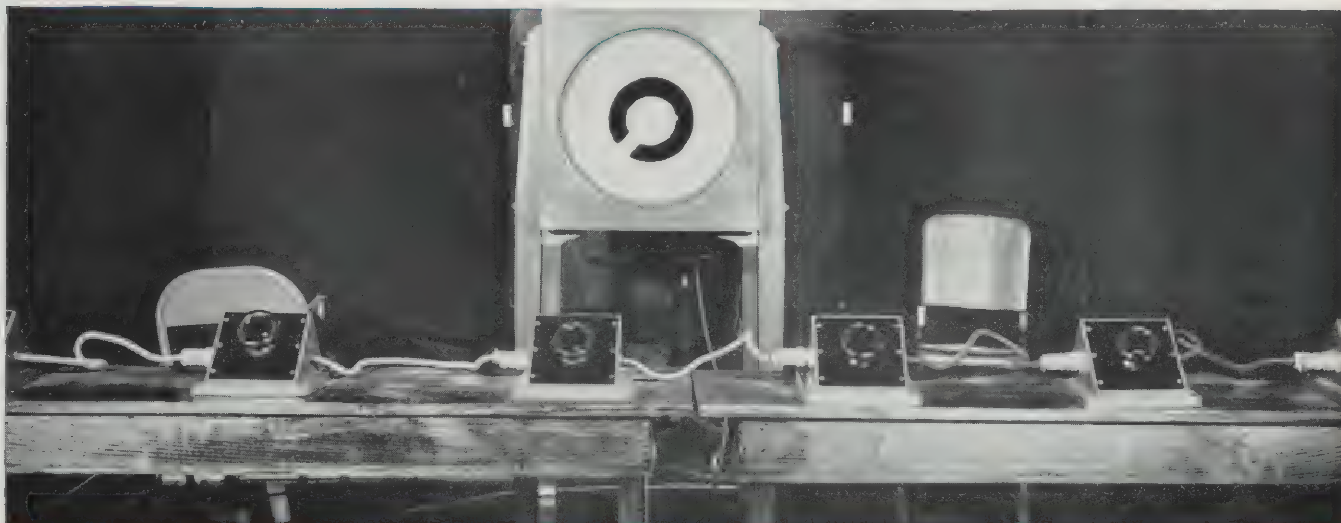
Preservation of dark adaptation. Every flyer's eyes should be as sensitive as possible before he flies over a blacked-out countryside or meets an enemy at night. If 30 minutes are spent in a dark room, the pilot's eyes will be satisfactorily dark adapted. However, individuals on fighter alert would have to remain in the dark constantly to be sure of being adapted when the enemy arrived. A practical solution utilizes the insensitivity of the rods to red light. An individual wearing red goggles can successfully preserve his rod adaptation in fairly bright illumina-

S.A.M. PORTABLE NIGHT VISION TESTER



HECHT-SHLAER ADAPTOMETER, MODEL NO. 3





AAF EASTMAN NIGHT VISION TESTER

tions without interference with his ability to read maps, magazines, or newspapers and to see others to whom he wishes to talk. The cones will become dark adapted in about 8 minutes after a pilot steps into the dark, while his rods, by virtue of the red goggles, are already fully adapted. On a dark night, the cone adaptation is unimportant since they are incapable of functioning in starlight illumination.

Dark adaptation of the rods develops rather slowly over a period of 30 minutes but can be lost in a second or two of exposure to a bright light. The night flyer must therefore be taught to avoid bright lights. He must know his airplane so well that no light is required to locate the controls. He should memorize his route so well that he need seldom refer to his maps. He must keep his instrument illuminated at the lowest level consistent with safe operation, and must avoid looking at the exhaust flame or the gun flashes. If he must use light, it should be as dim as possible and used for the shortest possible period.

Dark adaptation is an independent process in each eye. Even though a bright light may shine in one eye, the other will retain its dark adaptation if it is protected from the light. This is a useful bit of knowledge because if a flyer must use light for some purpose or is caught in the beam of a searchlight, he can preserve the dark adaptation in one eye by simply keeping that eye closed.

Cockpit illumination. The use of red light having a wave length greater than 6,000 Angstrom units for illumination of the cockpit is desirable from the viewpoint of dark adaptation. Under red light, the pilot may still use his central vision (foveal cones) yet retain the dark adaptation of the rods. From the standpoint of visibility to enemy pilots in the vicinity, red light is also to be preferred, for red light of low intensity is virtually invisible unless viewed directly. For this reason, all newer aircraft are equipped with a pivoted red light of variable intensity. The disadvantage of this type of light is that red markings on aerial maps are invisible when viewed in red light. Instrument panel illumination is achieved with dials painted with yellow green or orange paint which is both phosphorescent (self-luminous) and fluorescent (emitting light when activated by ultra-violet rays). Although red paint would be preferred to the currently used colors, technical considerations require the substitution of the others. Phosphoresence of the orange paint is usually inadequate to permit vision of the dials in darkness. Accordingly, an ultra-violet lamp on a pivoted base is also installed in the plane. This ultra-violet beam may be directed to the instruments most frequently used by the pilot. Ultra-violet light has a disconcerting side effect if directed or reflected into the eye. These radiations produce a fluorescence of the crystalline lens in the eye giving the pilot the sensation that he is flying in a sea of fog. This annoyance may be avoided by proper adjustment of the ultra-violet lamps and rheostatic reduction of their intensity. These radiations are not injurious to the eyes, for at highest intensities they are still far less than those present in sun-light.

Visibility of lights to the enemy. Light at the blue end of the spectrum is seen by the rods more readily than any other color; it is not seen as blue but is preceived as light. A blue light just visible to the rods as a colorless light would have to be increased 1,000 times in brightness before it could be seen as blue by the cones and before any use of central vision could be made. If a pilot exposed himself to blue light bright enough to allow central vision, he would then have lost all of his dark adaptation (rods) and require 30 minutes to regain it. Too, the enemy could pick up a blue light in any position of his peripheral field with ease, whereas a red light of low intensity would be invisible unless viewed directly.

Diet. Not only vitamin A but vitamin B and probably C are of distinct importance. For the therapy of *acquired* night blindness, a regime of 100,000 units of vitamin A and 5 mg of riboflavin daily is indicated in addition to a well balanced diet. The time required to effect a cure varies tremendously from one individual to the next, the average time being 3 months.

Age. Night visual ability is decreased by age, significantly so over the age of 40 years.

Drugs. The use of drugs systemically to improve night vision has been uniformly successful.

Anoxia. The effect of anoxia at altitude on night vision is primarily one of increasing the time required for complete dark adaptation to be attained. The actual elevation of the rod threshold at 16,000 feet without oxygen may be as much as 0.4 log unit. This may be significant from a practical point of view.

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DRUGS AND THE FLYER

Factors which most frequently modify the action of drugs in flight are *anoxia* and *fatigue*.

Drugs which increase tolerance to hypoxia

Substances which increase the partial pressure of oxygen in the alveolar air, that diminish the oxygen requirement of the organism, or act as respiratory stimulants may increase tolerance to hypoxia:

Ammonium chloride. It has been demonstrated that 10 to 20 gms of ammonium chloride a day for 3 days will increase the arterial oxygen saturation about 10% at 18,000 feet. This results in improved performance and a smaller acceleration of the pulse than expected. Unfortunately, such doses of ammonium chloride often produce gastrointestinal irritation. The probable mechanism of action is by an increase in the exhalation of carbon dioxide with a resulting increase in alveolar oxygen tension.

Glucose. Visual and psychomotor tests in humans suggest that the ingestion of glucose improves performance at altitude. There is some evidence that a low blood sugar interferes with oxygenation of the central nervous system so that a mild lack of oxygen may produce symptoms which would not occur with normal blood sugar. The higher alveolar respiratory quotient on a carbohydrate diet also plays a role in decreasing the alveolar carbon dioxide tension. These facts would seem to justify the ingestion of foods rich in carbohydrate immediately before a high altitude mission.

Analeptics. Under conditions of partial anoxia, benzedrine 10 mgm., pervitin (methedrine) 5 mgm., or caffeine sodium benzoate 500 mgm. improve psychomotor performance. There is some evidence that benzedrine is superior to caffeine for this purpose.

Drugs alleged to reduce tolerance to hypoxia

Sulfonamides. If the administration of sulfonamides results in an anemia or methemoglobinemia, or if the subject is abnormally susceptible, there is no doubt that tolerance to hypoxia is reduced. Otherwise, there is evidence that, of the sulfonamides, only sulfanilamide in moderate doses diminishes tolerance to hypoxia. From experiments at sea level there is evidence that sulfanilamide should not be used when doing exacting or strenuous work. Although depth perception and the phorias may be adversely affected by sulfathiazole or sulfadiazine there seems to be no significant effects on staring and vigilance, on dark adaptation, on mental efficiency or eye-hand coordination, on various intellectual and psychomotor functions under hypoxic conditions, or in the ability to perform exhausting work. The occasional abnormal toxic response to the sulfonamides evident at sea level may be aggravated by conditions of flight and in any case may be more dangerous due to the exacting demands of the situation.

Antimalarial drugs. Attempts to confirm earlier reports of toxic effects of atabrine, quinine and plasmochin have not been successful. Thus, there is no specific contraindication to the use of these drugs in flying personnel.

Drugs for decompression pain

So far there has been little progress in the search for drugs for the relief of decompression pain. The pain can sometimes be relieved by the use of morphine sulfate or morphine tartrate but due to its known depression of the respiratory center there is some question regarding the safety of its use. Further, the onset of analgesic action after subcutaneous administration is usually too slow to make it of practical value. Certain quicker acting analgesics might be of value but of those suggested trichlorethylene occasionally gives rise to cardiac disturbances. A new synthetic analgesic, Demerol, is almost as slow in its action as morphine given subcutaneously.

Drugs for airsickness

Most of these fall into two categories. They are either para-sympathetic depressants or central nervous system depressants (see Section 8-5). Some have been shown to be effective in seasickness and others are effective in relieving the motion sickness produced by a swing. Very few have received adequate testing in the air. Insofar as it can be determined there is good correlation between the effectiveness of drugs against the sickness produced by various types of motion. To be useful in flying personnel a drug should:

1. Diminish the incidence of airsickness.
2. Not impair the capacity to perform duties.
3. Not be toxic, habit forming or cause disagreeable symptoms.
4. Be active in a reasonably short time after oral administration.

Depression of the central nervous system renders the barbiturates of doubtful value for flying personnel Indeed in experiments on the swing and in

seasickness they have not been shown to be particularly effective nor do they seem to contribute to the beneficial effects of other drugs when used for motion sickness. Those studied include phenobarbital, barbital, amytal and pentobarbital. However, the Army Motion Sickness Preventive, containing sodium amytal, hyoscine and atropine is effective in swing sickness, seasickness, and in airsickness. Whether this is due entirely to its content of hyoscine and atropine has not been demonstrated.

Several drugs related to atropine have been shown to be effective in motion sickness. Studies with the swing, in seasickness and in airsickness all indicate that hyoscine is particularly effective and that 1-hyoscyamine is about three-fifths as effective while atropine and homatropine are of less value. On the swing it has been shown that the effectiveness of several mixtures is due almost entirely to their content of hyoscine and hyoscyamine. There are two recent studies in navigation students demonstrating that hyoscine alone is effective. Thus, the only remedy that can definitely be recomended for airsickness at the present time is hyoscine. This may be used as 0.75 mgm. of hyoscine hydrobromide. This dose should not be repeated more frequently than every 6 hours, since the drug is so slowly destroyed or excreted that after several doses at 6 hour intervals there are definite visual changes. There are no serious side effects from the administration of reasonable doses of hyoscine or of the Canadian Seasickness Remedy and the Army Motion Sickness Preventive, both of which contain hyoscine. Several other substances tested on the swing or in seasickness have been shown ineffective. These include benzedrine, methedrine, thiamine, and niacin.

Drugs for fatigue

Men may postpone sleep and fatigue and remain alert for many hours longer than they would normally if they receive benzedrine at appropriate intervals. Ordinarily the dose is 5mgm. of benzedrine sulfate repeated not more frequently than every 3 hours or 10 mgm. repeated not more frequently than every 6 hours. Benzedrine does not affect appreciably physical or mental efficiency in well rested subjects, but it does permit them to carry out their duties for many hours longer than they normally would. The drug is not habit forming in the sense that physical signs of withdrawal are produced. However, many find the stimulation pleasant and excessive use may occur. Overdosage will produce excessive excitement, headache and sleeplessness. Some people are unusually susceptible to the actions of the drug so that when practical all personnel should be tested with a 5 mgm. dose prior to its actual use under combat conditions. The drug is no substitute for rest or sleep but merely postpones the need for these.

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SECTION 9

PREVENTIVE MEDICINE

SECTION 9

PREVENTIVE MEDICINE

PRINCIPLES FOR CONTROL OF COMMUNICABLE DISEASES

Definitions

A communicable disease can be imparted from one person to another. A communicable disease is *infectious,* which means simply that it is caused by living, transmittible organisms, or *contagious,* which means that it is spread only by direct contact with infectious material. All infectious diseases are communicable, but not all are contagious. Malaria is communicable but not contagious; smallpox is both communicable and contagious.

A *contact* is an individual who has been exposed directly or indirectly to an infectious disease but presents none of its symptoms.

A *suspect* is a person who has been exposed to an infectious disease, exhibits one or more of its predominant symptoms but, for the time being, does not present symptoms that justify a positive diagnosis.

A *carrier* is a person who harbors and discharges the infectious organisms of a disease without presenting symptoms of that disease.

Classification

Communicable diseases are classified in the military service according to routes of transmission, because such classification is convenient from the viewpoint of control. There are 5 groups:

1. Respiratory.
2. Intestinal.
3. Insect-borne.
4. Venereal.
5. Miscellaneous: scabies, rabies, tetanus, and infectious jaundice.

Major principles of control

Importance of the military mission. Every measure should be employed to promote military efficiency by preventing disease from attaining such prevalence that it interferes with the mission of a command. But if any control measure interferes more with the accomplishment of the mission than will the uncontrolled disease itself, then that measure cannot be justified.

Controllable factors. Control of a communicable disease may be directed toward 3 factors: the source, the transmitting agency, and the susceptibles.

CONTROL OF FACTORS IN COMMUNICABLE DISEASE

SOURCES	TRANSMITTERS	SUSCEPTIBLES
Hospitalization of: Cases Carriers Suspects	Insect eradication by: Eliminating breeding Preventing development Killing adults	Prophylaxis
Physical inspection of: Contacts Suspects	Mess sanitation by: Inspecting personnel Safeguarding food	Immunization
Quarantine of: Contacts	Waste disposal of: Human wastes Kitchen wastes	General measures
	Water purification by: Chlorination	

Control at the source. Control at the source is effected by separating contacts, suspects, cases, and carriers, who constitute the source of disease, from the other two factors in the triad, the transmitting agents and the susceptibles. Hospitalization, physical examination, and quarantine are the principal means used for such separation.

Control of transmitting agents. Transmitting agents are controlled by their elimination or destruction. Insect eradication, mess sanitation, waste disposal, and water purification are examples.

Control of susceptibles. Susceptibles are protected by all the measures directed toward the other two factors. In addition, protection may be obtained by a *prophylactic treatment,* such as the administration of sulfadiazine to reduce the incidence of hemolytic streptococcal infections; and by *immunization* against specific diseases for which biologic toxoids, vaccines, and sera are available.

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CONTROL OF RESPIRATORY DISEASES

Importance

Respiratory diseases make up the most important group of communicable diseases occurring in the military service. Their large volume rather than their mortality makes them a threat to the military mission, because they contribute to marked reduction in the effective rate of a command.

Difficulty of control

Even when all the principles enumerated in AR 40-210 and in Section 9-1 of this book are applied to the control of respiratory diseases, complete control can hardly be attained and is usually only approached.

It is fundamental, however, that steps always be taken to put as much space as possible between the respiratory tract of one individual and that of his neighbors. Such steps are largely a matter of proper housing.

Military housing

Proper housing is the most important single factor in the control of respiratory disease in the army. Proper housing requires that attention be given to four items.

Space
Beds
Ventilation
Walls and floors.

Space allowances. The object is to put as much space as possible between individuals. Space allowances are set forth in AR 40-205. In hospital wards, at least 100 square feet of floor space and 1,000 cubic feet of air space must be provided for each bed, while in barracks the allowance is set at 40 square feet of floor space per man. These are minimum standards which must be increased in emergencies, and should be increased wherever possible.

Arrangement of Beds. The danger zone of droplet infections has a radius of about 5 feet. Where possible, the side bars of adjacent beds should be about 5 feet apart; but where this is not practicable, there are 3 means of meeting the situation:

1. Head-to-foot sleeping.
2. Staggering of beds. Staggering should be attempted whenever less than 3 feet can be left between beds.
3. Cubiclization protects a bed by a screen which should extend from one foot below the surface of the bed to 2 to 4 feet above the head of the bed, and should slope toward the foot of the bed. Shelter halves, sheets, or blankets may be used for screening. Cubicles are resorted to whenever there is a high incidence of upper respiratory infections, or when there are many recruits brought together, or when it is impossible to maintain 3 feet spacing of beds.

Ventilation. Good ventilation depends on the following:

1. A temperature of about 64-70°F; i.e., comfortably cool.
2. Gentle movement without draft; for practical purposes, a flow rate that is barely perceptible on the back of the hand. Such control may be obtained in weather characterized by a temperature of about 50°F by opening windows from the bottom on the upwind side of a building and from the top on the downwind side, allowing about 1.5 square feet of inlet and outlet for every 10 men in the room. Cantonment barracks have a heating system which requires the windows to be kept closed in winter time, ventilation being effected by a forced-draft principle or mechanical means.
3. Humidity sufficiently high to prevent dryness of the nose, throat, and skin. A pan of water near a stove usually allows enough water to evaporate to keep the proper amount of moisture in the air. Cantonment barracks have humidity controls incorporated into the heating systems.
4. Cleanliness, or freedom from offensive body odors, poisonous fumes, and irritant dusts.

Care of Floors and Walls. Walls and floors should be scrubbed and oiled often enough to prevent the resuspension of numerous bacteria by the activity of the men in the room. Spitting on the floor should be prohibited. A recent development in the form of an oil treatment for bedding, blankets, and floors is considered to be a major advance in the prevention of the spread of respiratory infections.

Sulfadiazine prophylaxis

The daily administration of 0.5 gram of sulfadiazine has been found to be effective in preventing the following diseases and should be given when an epidemic is impending: meningococcal meningitis, scarlet fever, rheumatic fever, and pneumococcal pneumonia.

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AR 40-210, Prevention and control of communicable diseases of man, 15 Sept 1942.
TB MED 112, Sulfadiazine prophylaxis of acute respiratory diseases, 1 Nov 1944.

CONTROL OF INSECT VECTORS OF DISEASES

Important insect vectors

The mosquito, the fly, and the louse are the most important insect vectors from a military point of view. Mosquito control is almost synonymous with the control of malaria. Fly control plays a large part in the elimination of intestinal diseases. Louse control is essential to the suppression of typhus fever.

General principles

Military insect control requires the protection of troops in movement as well as in fixed positions. Thorough control usually evolves from consideration of the following factors:

1. Knowledge of the characteristics of the pest to be eliminated.
2. Eradication of breeding and lodging places.
3. Selection of lethal agents most toxic to the pest to be eliminated.

MOSQUITO CONTROL

Environmenta measures.

- Protection against adult mosquitoes.
  - Selecting camp site.
  - Screening buildings.
  - Spray-killing with aerosol pyrethrum extract
  - DDT residue treatment
- Control of mosquito larvae.
  - Draining.
  - Filling.
  - Using larvicides.
  - Miscellaneous.

Individual measures.

- Malaria instruction and discipline.
- Suppressive treatment.
- Sleeping nets (mosquito bars).
- Repellents.
- Protective clothing.

FLY CONTROL

Environmental measures.

- Elimination of breeding ground.
  - Proper waste disposal.
  - Thorough policing of grounds and buildings.
- Prevention of development of the fly.
  - Proper waste disposal.
  - Use of heat and chemicals.
- Destruction of adult flies.
  - DDT residue.
  - Trapping.
  - Fly paper.
  - Swatting.
  - Spraying.

Individual measures.

- Proper waste disposal.

LOUSE CONTROL

Environmental measures.

- Prevention of infestation.
  - Prevention of crowding.
  - Organization of disinfestation zone into infested, disinfesting, and disinfested division (as at entrance to typhus hospital).
- Destruction of lice.
  - DDT dust
  - Fumigation (buildings or vaults).

Individual measures.

- Maintenance of personal cleanliness.
- Delousing.
  - Use of insect powders and sprays.
  - Fumigation (clothing bags).
  - Bathing and barbering.
  - Use of steam (for clothing).

REFERENCES SGO Circ. Ltr. 22, Military malaria control, 16 Jan 1943. FM 21-10, Military sanitation and first aid, 31 Jul 1940. TC 108, Military control and malaria discipline, 21 Sept 1943. TF 8953, Malaria—cause and control, 1943.

THE CHEMICAL CONTROL OF INSECTS OF MILITARY IMPORTANCE*

INSECT	PLACE OF TREATMENT	INSECTICIDE	AMOUNT AND METHOD USED	TOXICITY TO HUMANS
Mosquito and fly adults.    	1. Inclosed spaces as barracks, rooms, barns, airplanes, etc.	1. AEROSOLS (**) a. PYRETHRUM-DDT AEROSOL (0.4% Pyrethrins + 3% DDT + 5% cyclohexanone + 5% lube oil in Freon.) QM #51-1-159.	Spray 4 sec. per 1000 cu. ft. N.B. Spray 17 sec. per 1000 cu. ft. for airplane disinsectization.	Studies indicate non-toxicity when used properly at recommended dosages.
		b. PYRETHRUM AEROSOL. 1% pyrethrins + 2% sesame oil in Freon. QM #51-1-159.	Aerosol bomb—spray 4 sec. per 1000 cu. ft. Spray into air.	None
		2. DDT CONCENTRATED FLY SPRAY (3% pyrethrins + 20% DDT + 20% cyclohexanone + 5% lube oil in kerosene.)	1 cc. per 1000 cu. ft. when sprayed from the Orlando pocket size dispenser. (***) Excellent for use in forward military positions.	Studies on small animals indicate non-toxicity when used properly at recommended dosages.
		3. DDT SPRAY RESIDUE DEPOSIT. a. DDT IN KEROSENE (5% DDT in crude kerosene). Straight DDT, QM #51-L-120; 5% DDT in kerosene. QM #51-1-305. Note: DDT is an abbreviation for dichloro-diphenyl-trichloroethane.	Heavy spray on interior of buildings (1 qt. per 250 sq. ft.) Particular attention to where flies and mosquitoes rest. One application will eliminate flies and mosquitoes from treated buildings for 3-6 months. N.B. Highly recommended for control of all domestic type mosquitoes and flies. TREAT NATIVE SOURCES.	Same as (1a) above.
		b. DDT WATER EMULSION CONCENTRATE. (25% DDT + 7% Triton X-100 + 68% xylene). QM #51-1-156-95.	1 part concentrate with 4 parts of water and use same as in (3) above.	Studies indicate non toxicity when used properly at recommended dosages.
		4. PYRETHRUM EXTRACTS. (1 lb. pyrethrum, containing 1% pyrethrins, per gallon of kerosene.)	100 cc. per 1000 cu. ft. Spray into the air.	None.
		5. PYRETHRUM PLUS SYNTHETIC ORGANIC COMPOUNDS such as Thanite. QM #51-1-169.	100 cc. per 1000 cu. ft. Spray into the air.	None. Irritating to some.
	2. Outdoors, by spraying from airplanes (M-10 tanks, bomb bay tanks, oildrums carried in C-47s, etc., or by Cub Spray Unit adaptation).	5-10% DDT in water emulsion, kerosene, lube oil, Diesel oil, or combinations of these materials. Note: Experiments are now being done to determine the feasibility of smokes in this work. These materials are sprayed onto airplane exhaust manifolds.	FAST MOVING PLANES—see findings AAF Board. SLOW MOVING PLANES—2 qts. of 5% DDT per acre will greatly reduce adult population and control mosquito larvae. Use 5-10 gallons of 5-10% DDT per acre for a residue spray effective over a longer period. Material poured or sprayed into slip stream of plane in various ways.	Probably non-toxic when used properly at recommended dosages.
	3. In jungles (ground treatment)	1. AEROSOLS (see 1a and 1b above)	Tie aerosol bomb to end of stick and spray 6 inches from ground (bomb horizontal). Apply in swaths at 20 ft. or 7 pace intervals. One bomb per acre controls mosquitoes in jungles for about 12 hrs. Temporary mosquito control in bivouac areas.	None.
		2. DDT SOLUTIONS. (5-10% DDT in kerosene or as a water emulsion).	Atomize 1 qt. per acre in underbrush for temporary control. Use 5-10 gallons per acre for a longer period of control. Excellent reduction of mosquitoes and flies.	Studies indicate non-toxicity when used properly at recommended dosages.
Mosquito larvae. 	Rivers, lakes, swamps, pools, ruts, and water containing receptacles around houses.	1. DDT WATER EMULSION CONCENTRATE (25% DDT + 7% Triton X-100 + 68% xylene. QM #51-1-156-95.	Dilute 1 part concentrate with 24 parts water. Use 5 quarts per acre. Apply with a fine spray nozzle with main emphasis where aquatic vegetation or debree is thick, particularly along water margins. Lasts 7 to 10 days.	Same as above.
		2. DDT OIL SOLUTIONS (1% DDT in kerosene, Diesel, fuel, or crankcase oil.)	Prepare by adding 2 lbs. DDT per 25 gallons of oil. Use 5 qts. 1% DDT per acre of water. Emphasis on water margin treatment as above.	Same as above.
		3. 5-10% DDT in water emulsion, kerosene, lube oil, Diesel oil or combinations of these materials.	Spray from airplanes. Amount and method as listed above for adults.	Same as above.
		4. PARIS GREEN (Copper aceto-arsenite containing 50% plus of arsenious oxide. QM #41-7839. 7-7.	1 lb. Paris Green per acre. For hand or power dusting dilute to 5-10% with inert dusts such as road dust fine sand, talc, hydrated lime, condemned flour. As an airplane dust dilute to 25%. Apply every 7-10 days. For control anopheles mosquito only.	Very toxic if eaten. Non-toxic in water at recommended dosages.
		5 PETROLEUM OIL. Light fuel oil of #2 grade or "Bunker C" diluted ⅓ with kerosene. QM #7-0-200 (fuel).	15-25 gallons per acre depending on density of aquatic vegetation. Applied by spray, drip cans, and other methods. Apply every 7-10 days. For general mosquito control.	Essentially non-toxic.

INSECT	PLACE OF TREATMENT	INSECTICIDE	AMOUNT AND METHOD USED	TOXICITY TO HUMANS
Lice (cootie, greyback). 	1. On body and clothing	1. DDT POWDER (10% DDT in pyrophyllite or other inert dusts). 2 ounce cans. QM #51-I-173; Bulk, QM #51-I-180.	MASS TREATMENT. Thoroughly dust between inside garment and skin itself by applying dust gun at all openings of clothing. Use 1.5 ounces per individual. Body lice are most frequently found in the seams of clothing. INDIVIDUAL TREATMENT. Apply powder from sifter top can over the entire inner surface of underwear and treat seams on the inside of shirt and trousers, use one (1) ounce powder.	Essentially non-toxic.
		2. MYL POWDER	Same as for DDT louse powder 1 above Ovicidal.	None
	2. Body	1. BENZYL BENZOATE CONCENTRATE (68% benzyl benzoate + 12% benzo-caine + 6% DDT + 14% Tween 80). QM #51-I-310.	Dilute concentrate 1 part with 5 parts of water and spray hairy parts of body with about 20 to 30 cc. of the liquid.	Studies indicate non-toxicity when used properly at recommended dosages. Protect eyes during application.
Fleas. 	3. Clothes impregnation	1. DDT WATER EMULSION CONCENTRATE. QM #51-I-156-95.	Dilute to 2% DDT. Use ordinary laundry facilities. 1 pt. per suit of underwear.	Studies indicate non-toxicity when used properly at recommended dosages.
	4. Mass clothing treatment	1. METHYL BROMIDE (danger) QM #51-M-892.	8 lbs. per 1000 cu. ft. for half hour. Use in specially constructed fumigators. To be used by experts only.	Very toxic. No warning odor.
	1. Rooms	1. DDT OIL SOLUTION (5% DDT in kerosene) QM #51-I-305.	1 gallon 5% DDT in oil per 1000 sq. ft. will give good results. 2 lbs. DDT in 5 gallons oil.	Studies indicate non-toxicity at recommended dosages.
		2. MYL POWDER	Liberal application on infested areas (rugs, floors, rubbish, etc.)	Non-toxic.
		3. NAPHTHALENE (moth flakes)	3 lbs. per 1000 cu. ft. Thorough dusting on floor, especially cracks. Overnight fumigation.	Not toxic unless eaten.
		4 PARADICHLOROBENZINE	Same as 3 above.	None
Bedbugs (Chinches). 	2. Animals	1. DDT DUST (10% in pyrophyllite) QM #51-I-180.	Light application over animal.	Somewhat toxic to animals.
		2. DERRIS POWDER	Thorough application over animal.	None
	Inclosed spaces	1. DDT OIL SOLUTION (5% DDT in oil) QM #51-I-305.	3 to 4 gallons per 74-man barracks. Thoroughly spray mattresses, beds, and into cracks and crevices in wall, with particular attention to springs and the corners of beds. Residual effect of a year or more.	Studies indicate non-toxicity when used properly at recommended dosages.
Roaches. 		2. HYDROGEN CYANIDE (Danger) QM #51-C-418.	To be used by experts only.	Extremely toxic.
		3. PYRETHRUM EXTRACTS (1 lb. per gallon of kerosene).	Thorough wetting of cracks and crevices containing bedbugs. For minor infestations. Repeat.	None
	Inclosed spaces	1. DDT DUST (10% in talc) QM #51-L-122.	Apply by hand duster with particular reference to cracks, crevices, and behind objects. Dust near water supply.	Studies indicate non-toxicity when used properly at recommended dosages.
		2. AEROSOLS.	Spray into air after opening cabinet drawers, doors, etc. Spray 15 to 30 sec. per 1000 cu. ft. Repeat.	None
Mites (Chiggers) redbugs, harvest mites. 		3. PYRETHRUM POWDER	Thorough dusting of cracks and crevices especially around water. Repeat.	None
		4. SODIUM FLUORIDE (should be colored)	Thorough application to infested areas. Keep dry.	Very toxic if eaten.
	Body	1. DIMETHYLPHTHALATE (See repellents) Toxic to mites.	BARRIER TREATMENT. Apply thin layer ½" wide along all openings of uniform and socks. Good until uniform is washed. Most rapid acting. CLOTHES IMPREGNATION. Make 2% soap emulsion in water and add 5% Dimethylphthalate. Dip outer clothing in it.	Non-toxic.
		2. SULFUR DUST (1:3 with talc)	Thorough dusting of legs and lower body especially around belt.	Irritating to groins and armpits.
Sarcoptes, (Scabies, mange). 		3. COLLODIAN SOLUTION (finger nail polish) Note: not an insecticide, gives quick relief to irritated areas.	Apply to affected areas.	None
	Body	1. BENZYL BENZOATE CONCENTRATE. (68% Benzyl benzoate + 6% DDT + 12% Benzocaine + 14% Tween 80 (emulsifier) QM #51-I-310.	Dilute 1 part concentrate and 5 parts water. Apply as spray or by hand over body except head.	Studies indicate non-toxicity when used properly at recommended dosages.
		2. SULFUR OINTMENT (5% sulfur in lanolin)	Thorough application to affected parts.	Somewhat irritating.
Insect repellents (flies, mosquitoes, gnats, mites, sandflies, fleas, ticks, etc.). 	Exposed surfaces of body and clothes	1. 6-2-2 (6 parts Dimethylphthalate + 2 parts Indalone + 2 parts of 612, mixed mechanically) QM #51-R-265 (2 ounce bottle)	APPLICATION ON SKIN. ½ teaspoonful into palm of hand, rub hands together and then apply in thin layer to face, neck, ears, hands, and wrists. Lasts 1-2 hours. Care not to get in eyes and mouth. ON CLOTHES. Spray or apply by hands on clothes. Effective for a number of days. Best all around repellent. Combines good qualities of three ingredients.	Non-toxic. Very irritating to the eyes.
		2. DIMETHYLPHTHALATE (QM #51-R-300) (bulk).	Particularly effective against anopheles and larval mites (chiggers). Use same as (1) above.	Same as above.
		3. INDALONE	Same as (1) above. Best use against biting flies.	Same as above.
		4. 2-ETHYL HEXANEDIOL-1-3 (repellent 612)	Same as (1) above. Particularly effective against aedes.	Same as above.

For more complete information see Tropical Disease Report No. 19, Office of Scientific Research and Development.
**United States Department of Agriculture Public Service Patent by Goodhue and Sullivan.
***United States Department of Agriculture Public Service Patent filed by Schroeder and Lindquist of the Orlando Laboratory.

WATER

Responsibility for any system of water supply is divided.

Construction Maintenance Distribution	Zone of Interior (in wartime) **QUARTERMASTER CORPS**
Purification Quantity Quality	Theatre of Operations (except smaller units) **CORPS OF ENGINEERS**

Sanitary survey of	Source Adequacy Potential contamination Bacterial content Chemical content	MEDICAL DEPARTMENT
Inspection of system	Appliances Distribution Procedures in treatment Purification apparatus	
Emergency water procurement and purification		
Recommendations		

Water Reconnaissance. The Corps of Engineers is responsible for the procurement and purification of water for major units and installations in the theater of operations and for water reconnaissance where such action is necessary. Where intestinal disease is, or may become, epidemic, the Medical Department assists in or actually makes water reconnaissance, and submits recommendations concerning the procurement and purification of water supplies. In the case of small units and installations operating independently, the engineering personnel may not be available for this purpose and the responsibility for water reconaissance will devolve upon Medical Department personnel attached to such organizations.

Procedure. Information as to the location and extent of sources of water supply in a given area may be obtained from geological or topographical maps, from government reports, from natives, from aerial photographs, or by reconnaissance on the ground. The purpose of a water reconnaissance is to locate a suitable source of supply and determine, if indicated, the quantity of water available from a given source, the time and labor required to develop it, and the quality of the water insofar as it will influence purification.

Purification of water. Engineering units are equipped with equipment for the purification and storage of large quantities of water.

The squadron, or similar unit, or even the group may have to carry out the purification of its own water in the absence of these units. In this event the canvas water sterilizing bag (Lyster bag) of 36 gallon capacity is used. The bag is also used for the distribution of water previously made potable by a water purification unit or other means. Where the Lyster bag is used for the purification of water, the chlorination of the water should be under the direct supervision of Medical Department personnel.

The technique of purification when using the water-sterilizing bag may be found in FM 21-10. If water sterilizing bags are not available, the water may be purified in water cans, drums, or barrels. A proportional amount of calcium hypochlorite is used and the method of chlorination is the same as with the water sterilizing (Lyster) bag.

If large containers are not available, canteens may be used. One-half gram of grade A calcium hypochlorite is dissolved in a canteen of water and this strong solution is used to purify water in other canteens. The cap of a canteen is used as a measure and one canteen cupful of the strong solution is added to each canteenful of water to be treated. The water should be well shaken and not used until 30 minutes after chlorination.

Two halazone tablets may be used for treating water in individual canteens. Water should not be drunk for 30 minutes after the tablets are added.

Iodine may be employed as a disinfectant instead of chlorine. Ten cc of the tincture of iodine are used to treat a Lyster bagful of water. Two or three drops are used to treat a canteenful of water. In the treatment of some waters iodine is much less effective than chlorine. The water should not be used until 30 minutes after the iodine has been added.

Water may be purified by boiling for 10 minutes. If avoidable this method should not be used by the individual soldier, but the water should be boiled under supervision in comparatively large quantities and then distributed to the troops. Aeration of the water by pouring it from one receptacle into another will eliminate the flat taste due to boiling.

REFERENCES

FM 21-10, Military sanitation and first-aid, 31 Jul 1940

DISPOSAL OF WASTE

Classification of wastes

1. Human excreta (feces and urine).
2. Garbage.
3. Liquid wastes (kitchen, bath, ablutions).
4. Manure.

Responsibility for disposal

Unit commanders are responsible in their areas for disposal of all waste. The scope of the sanitary control exercised by the Medical Department includes the following activities:

1. The survey of sites and review of plans for installation of permanent or temporary facilities for disposal of wastes.

2. Inspection of existing facilities for defects in construction and operation which may be of sanitary significance.

(Although Medical Department personnel are not directly responsible for the construction and maintenance of sanitary devices, it is frequently true that such responsibility will be delegated to the flight surgeon by the commanding officer.)

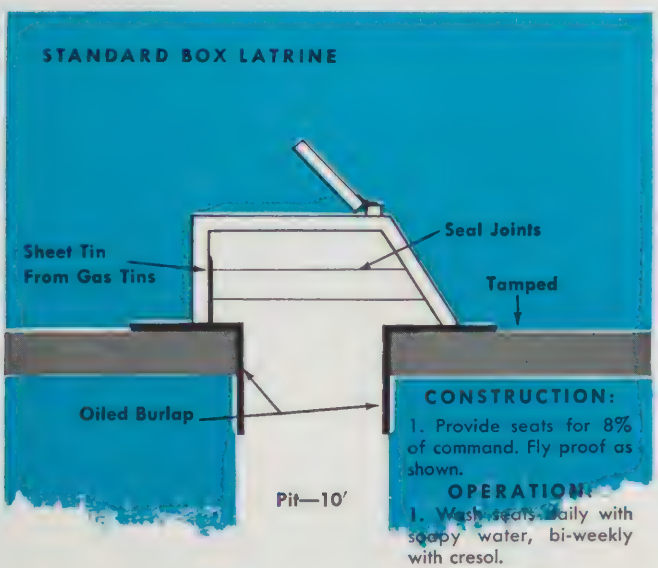
Human wastes

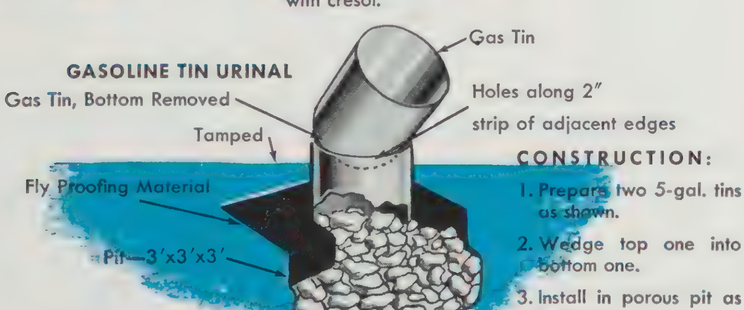
In many semi-permanent camps, human feces may be disposed of by a *water carriage system*. More often in a theater of operations, other disposal facilities must be used.

Human wastes are usually disposed of by Mosaic, or "cat", latrines on short halts, by shallow trench latrines in camps of less than one week's duration, and by deep pit latrines, pail latrines, or other improvised methods in camps of more than one week's duration. Details concerning the construction of latrines and urinals may be obtained by reference to FM 21-10 and to TO 00-80B-1.

Regardless of the installation used, there should be sufficient latrine facilities to accommodate 8% of the command at any one time.

Latrines should be at least 100 yards distant from messes and at least 100 feet from any well or spring.





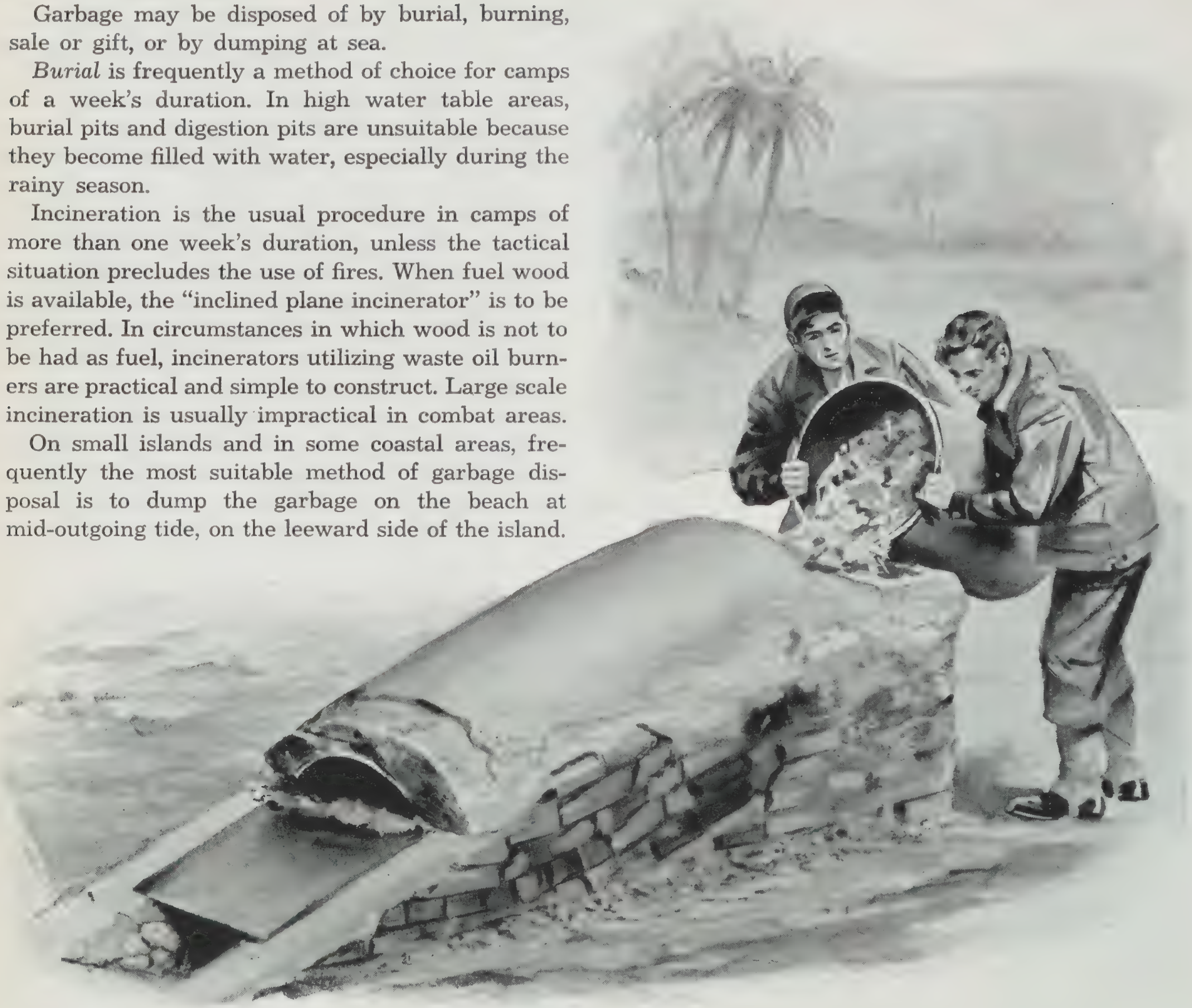
Disposal of garbage

Garbage may be disposed of by burial, burning, sale or gift, or by dumping at sea.

Burial is frequently a method of choice for camps of a week's duration. In high water table areas, burial pits and digestion pits are unsuitable because they become filled with water, especially during the rainy season.

Incineration is the usual procedure in camps of more than one week's duration, unless the tactical situation precludes the use of fires. When fuel wood is available, the "inclined plane incinerator" is to be preferred. In circumstances in which wood is not to be had as fuel, incinerators utilizing waste oil burners are practical and simple to construct. Large scale incineration is usually impractical in combat areas.

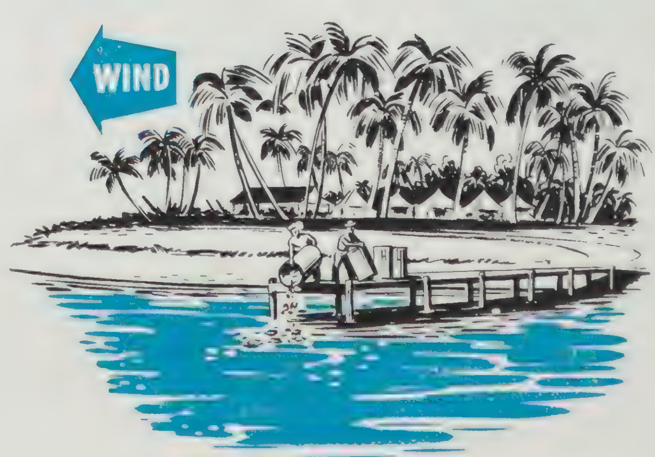
On small islands and in some coastal areas, frequently the most suitable method of garbage disposal is to dump the garbage on the beach at mid-outgoing tide, on the leeward side of the island.



While changing tides offer certain problems, they are usually less serious than the practical difficulties of incineration or burial on these small islands.

Burial of garbage by the *sanitary fill* method ordinarily is a large scale operation intended to accommodate the garbage of 10,000 men or more per day. The same method can be adopted, however, to dispose of the garbage of 50 to 400 men. Disposal by sanitary fill is practical where the level of subsurface water is more than 8 feet from ground level, the soil is soft enough to be shoveled, and the porosity is sufficient to prevent collection of rain water.

A small incinerator heated with a *flash burner* can dispose of the garbage of at least 350 to 400 men daily. The burner uses about 1½ gallons of waste oil



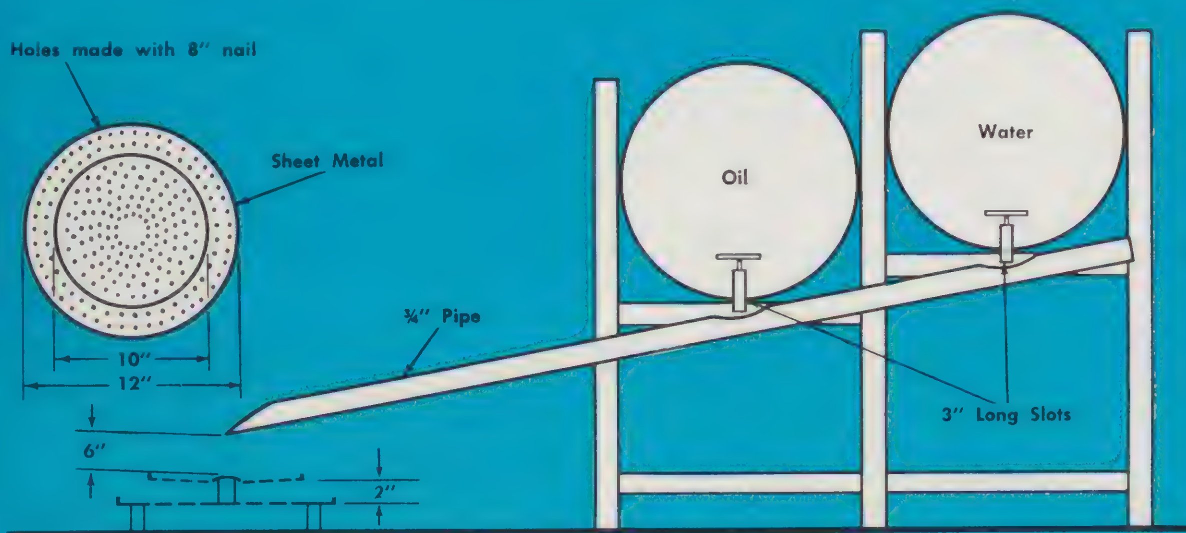
per hour and requires little attention during operation.

Is is essential to separate liquids from solid garbage when using the burial or incineration methods of disposal. A screen or burlap strainer can be used for this purpose, or a G.I. can with a perforated bottom. The strained liquid is then disposed of as indicated below.

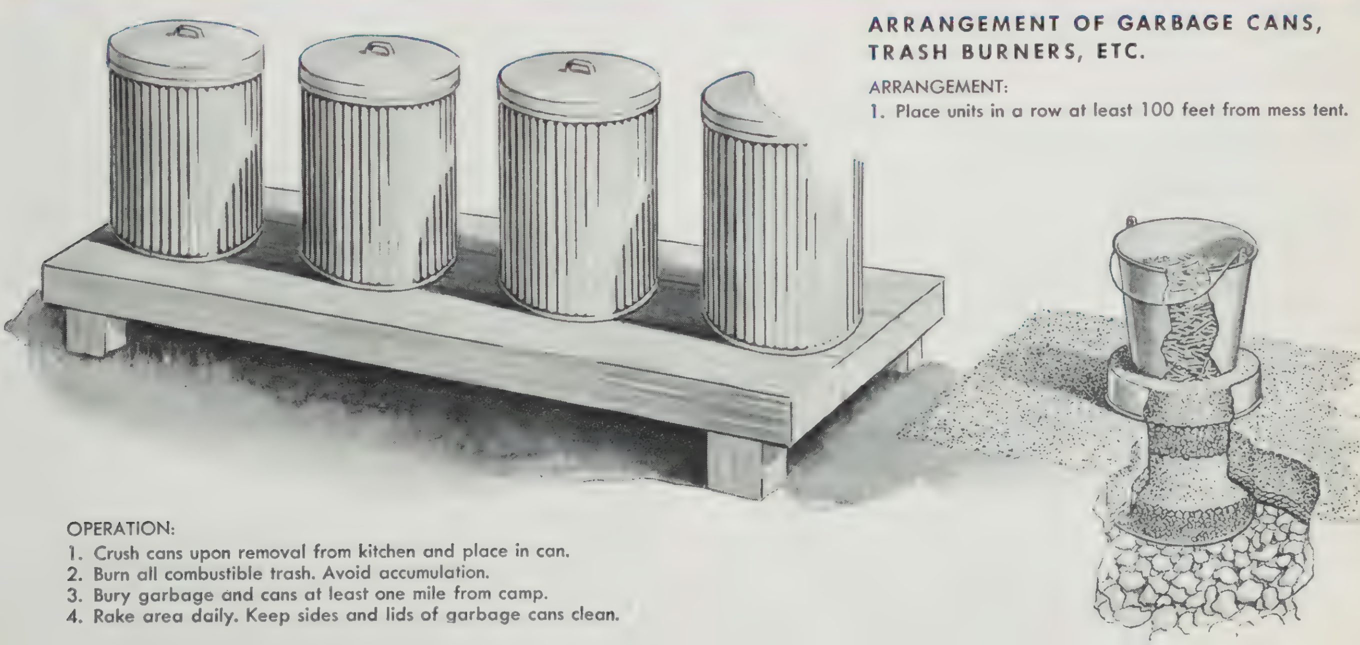
In order to minimize the danger of spilling garbage during transportation, the cans should not be filled beyond 4 inches from the top. The lids should be kept on at all times except when removed to deposit or remove garbage.

The platform should be scrubbed daily with a stiff scrubbing brush and hot soapy water, and the ground about the stand should be sprayed at weekly intervals with crude oil and firmly tamped. Intervals between collections should not be more than 2 days in the summer and 3 days in the winter. Garbage cans should not be whitewashed or painted.

OIL-WATER FLASH BURNER



CONSTRUCTION: 1. Perforate 2 sheet metal disks with an 8″ nail. 2. Shape and fasten together. 3. Assemble tanks and supply pipe. 4. Place in fire box. Operation: 1. Pre-heat upper plate with a piece of burning waste. 2. Start oil and water flow to obtain flashing.



ARRANGEMENT OF GARBAGE CANS, TRASH BURNERS, ETC.

ARRANGEMENT:
1. Place units in a row at least 100 feet from mess tent.

OPERATION:
1. Crush cans upon removal from kitchen and place in can.
2. Burn all combustible trash. Avoid accumulation.
3. Bury garbage and cans at least one mile from camp.
4. Rake area daily. Keep sides and lids of garbage cans clean.

Disposal of liquid waste

Where sewers are available, liquid kitchen wastes may be disposed of by dumping directly into *sewer lines.* In most camps, especially in overseas areas, this is impossible, and some arrangement must be made to dispose of these liquids in the soil. *Soakage pits* and *soakage trenches* may be greatly limited in their usefulness by several factors: permanent ground frost in arctic regions, or heavy rainfall, high water table, and poor soil drainage elsewhere. *Dumping at sea* is a solution applicable only to a limited number of AAF installations. *Incineration* of liquid waste is usually impractical. The difficulties of disposing of liquid waste in the tropics make it essential to apply all current methods in the most efficient manner.

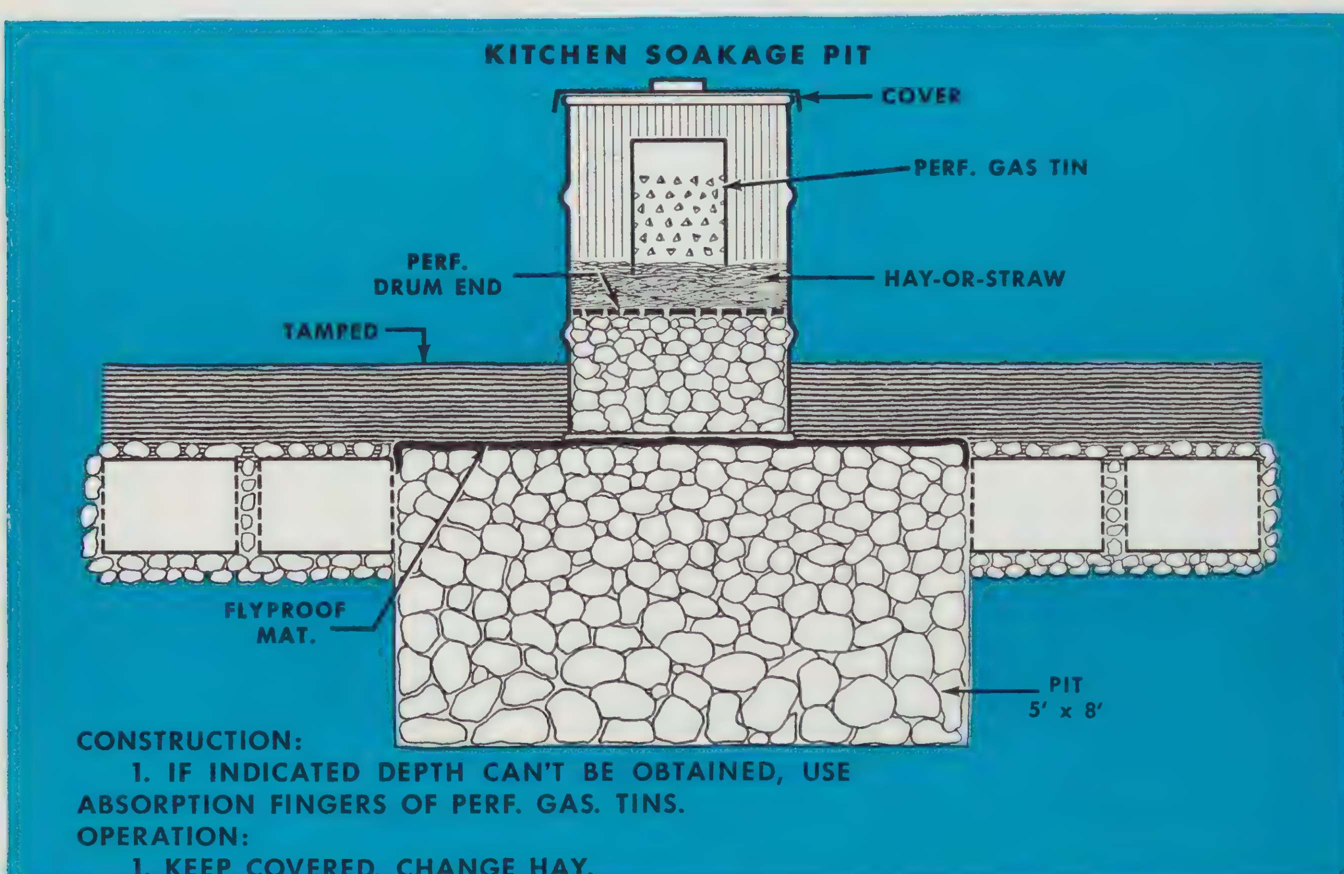
Previous to disposal of the waste water by soakage or evaporation, every effort must be made to separate fats and soap. This is done by means of a *grease trap.*

Soakage pits act as reservoirs from which water is gradually absorbed by the surrounding ground. Their effectiveness depends upon the clearness of the water poured into the pit, the height of the ground water table, the porosity of the soil, and the extent of the soakage surface. In terrain of rapid drainage, such as limestone or coral, small pits will function for long periods of time. In slow-draining, silty, or clay soils, pits must be much larger. Great care must be taken in slow drainage areas to clear waste water thoroughly before running it into a soakage pit.

Where the surface is rocklike and non-porous, soakage pits and trenches are difficult to construct and will function only a short time. In such areas, if the climate is hot and dry, waste water can be disposed of satisfactorily by evaporation beds. These will operate partially by evaporation and partly by absorption and by oxidation of the waste. In order not to clog the beds, the waste water must be thoroughly freed of grease.

REFERENCES

FM 21-10, Field sanitation and first aid, 31 Jul 1940.
TO 00-80B-1, Improvised combat sanitation, 15 Oct 1944.



SANITATION OF THE MESS

The following outline for the conduct of a "mess inspection" will facilitate maintenance of sanitation in the mess:

Police of grounds about the mess.

Food supplies

Canned goods—sufficient supply, presence of swellers, springers, or leakers.

Fruits and vegetables—source (possibility of contamination), washing, and sufficient cooking.

Milk and dairy products—source, quality, freshness, handling, storage, bacteriological and chemical analysis, raw or pasteurized milk.

Meat and fish—source, quality, handling, transportation, inspection at receiving point, storage, refrigeration, and preparation.

Bread and bakery products—source, quality, how delivered, cleanliness of vehicle and storage.

Food storage

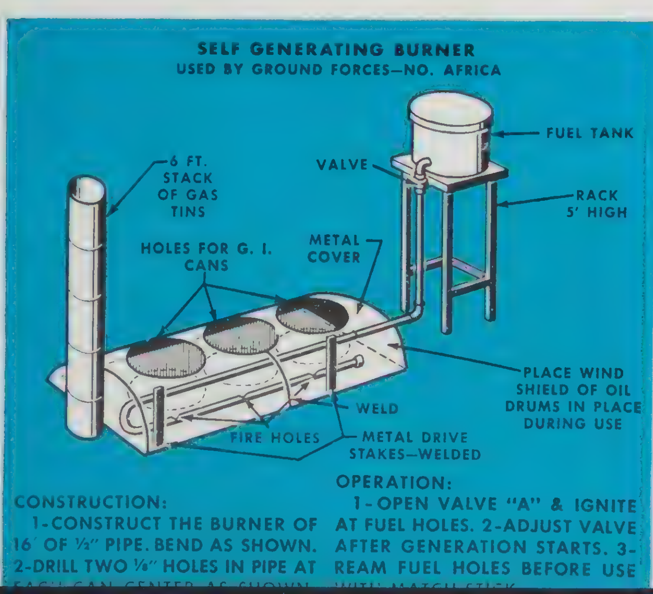
Storage tents or pantries—type of flooring, cleanliness, adequacy of space, general arrangement, condition of vegetable bins and wastage.

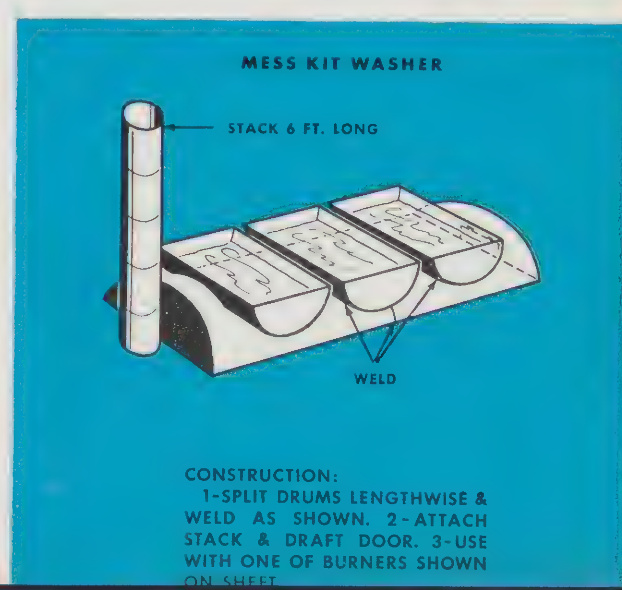
Refrigerator—adequacy of size, temperature, cleanliness, hooks for meat, duck boards for perishable vegetables, left-overs, disposal of drip water, presence of vermin.

Attendants. Qualifications of mess sergeant; adequately trained cooks; examination of food handlers by surgeon, frequency of such examination; native laborers, system of control; posted certificates of health examinations; cleanliness of food handlers, clothing, hair and scalp, hands, fingernails, washing of hands, and washroom facilities.

Menus. Food served corresponding with menu posted, balance, variety, and rotation of menus.

Food preparation. Adequate cooking, overcooking,





tasteful seasoning, meals prepared in systematic fashion, adequate facilities for proper preparation, protection from time of cooking until ingestion by personnel, food served so as not to detract from group appetite, and wasteful serving.

Dishwashing. Does the method meet the requirements of Army Regulations, control of native dishwashers, cleanliness of dishes, trays, utensils, evidence that all dishes and utensils have been sterilized and air-dried?

Kitchen utensils. Pots and pans grease-free; storage of utensils; knives and forks; cleanliness of racks, shelves, can-openers; and cleanliness of ranges.

Police of Kitchen. Cleanliness of floors, walls, and ceiling; presence of accumulated dirty and greasy rags; condition and construction of table tops, accumulation of personal belongings of mess personnel in kitchen.

Waste disposal. Proper sorting and removal of waste to garbage cans at garbage rack, cleanliness; condition of ground surrounding garbage rack; garbage removed on regular schedule; garbage can lids fit tightly; no transfer of garbage from can to can at the rack; provision for clean containers; condition and adequacy of garbage soakage pit (if used); screening and condition of grease traps.

Insects and Rodents. Presence of breeding and hiding places for insects and rodents; adequacy of screening; fly control and proper baiting and maintenance of fly traps; improvisations for control; roach control program, control measures carried out; type and effectiveness of rodent control; indoctrination of mess personnel in control measures.

Investigation of suspected food poisoning

If an outbreak of diarrhea or dysentery should occur in a unit, the following check list will be of value in investigating the possible cause:

Date of outbreak.

Mess involved.

Number of persons served at suspected meal.

Number of persons affected.

Which organization.

Time interval between suspected meal and onset of symptoms.

Symptoms (yes or no). Nausea; vomiting; diarrhea, bloody; headache, chilliness; abdominal pain; prostration; others.

Duration of symptoms. Was recovery complete in all cases?

Complete menu served at suspected meal.

Comon denominator of foods eaten by all affected individuals.

Sources of these foods.

Condition of canned foods.

Amount of cooking.

Time interval between preparation and actual serving.

Condition of refrigeration and handling before serving.

Food Handlers:

Illness among food handlers at time of outbreak.

Pyogenic skin infection among food handlers.

Bacteriological examinations:

Results of bacteriological examinations of suspected foods.

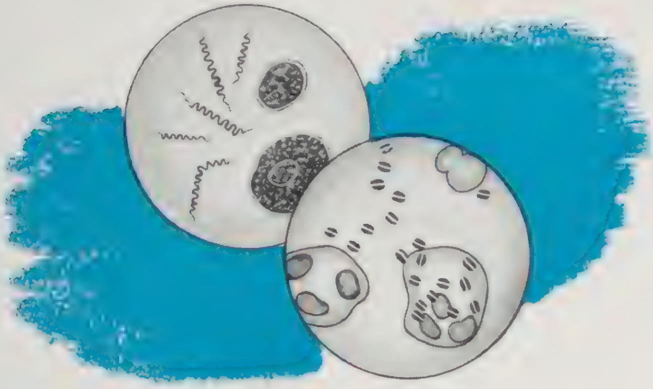
Results of bacteriological examinations of stools of food handlers and affected persons.

REFERENCE

FM 21-10, Military sanitation and first aid, 31 Jul 1940.

Dunham, G. C.: Military preventive medicine, Harrisburg, Military Service Publishing Co., 1940.

TO 00-80B-1, Improvised combat sanitation, 15 Oct 1944.



CONTROL OF VENEREAL DISEASE

Objectives

1. Reduce incidence of infection by decreasing promiscuous exposure and by protecting the individual against infection, if exposed.

2. Reduce the period of disability by improving methods of treatment and by facilitating administration of cases in hospital.

Command responsibility. Cooperation of commanders at all levels in indoctrination of men; maintenance of morale and discipline; provision of adequate recreation; provision of facilities for prophylaxis.

Essentials of control

Command coordination. Medical officers are responsible for the health aspects of venereal disease control; chaplains for the moral aspects; the provost marshal for policing; special services for recreation.

Education. This is given by the Medical Department and is to include the nature of venereal disease. how acquired, how prevented. It must include instruction of officers and enlisted men with special stress on the responsibility of officers. Lectures, pamphlets, posters, training films and film strips are to be used. The program should be coordinated with other training, length of military service and related to type of duty.

Epidemiology. Effort must be made to identify and trace possible sources of infection and individuals exposed to infection through the use of contact information. Cooperation with civilian health agencies is essential for epidemiological control.

Prophylaxis. This includes the explanation of the use of prophylatic items and provision of adequate material and facilities. In a sense it also includes early diagnosis and treatment of venereal disease.

Civilian community cooperation. Local health departments aid in the identification and control of infected individuals; police departments help in the prevention and correction of legal violations contributing to increased venereal disease (houses of prostitution, poorly policed taverns, control of street pick-ups); service organizations help by providing wholesome recreational facilities.

Prophylaxis

Personal. All personnel should be instructed in the use of the one tube prophylactic kit—"Prokit"—Medical Supply Catalogue No. 9118000. Individual chemical and mechanical prophylactic materials are supplied on requisition from the medical supply officer.

At station. The prophylaxis should be administered or closely supervised by a trained attendant. It is most effective when given within one hour after exposure.

The exposed subject urinates and washes his hands.

He washes his penis, scrotum, and adjacent area of the body thoroughly with liquid soap and warm water. These parts are dried and then flushed with a 1-1000 solution of bichloride of mercury. With a urethral syringe the attendant gently injects 5 cc. of a 2% solution of protargol (prepared fresh once a week) into the anterior urethra. The subject retains this solution for *five minutes by the clock.* Small amounts of the protargol are permitted to escape at brief intervals in order to keep the meatus well bathed.

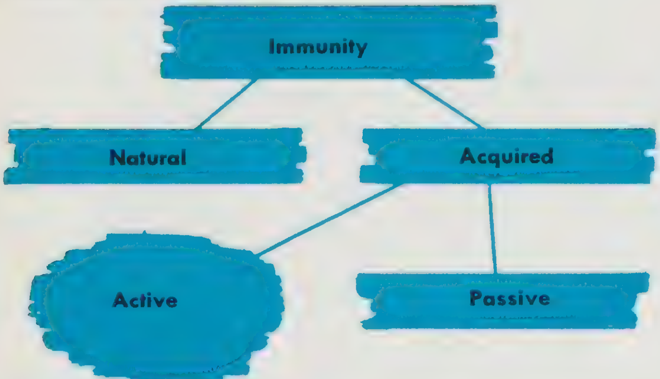
The subject retracts the foreskin, then thoroughly rubs into the penis and surrounding body area about 4 grams of 30% calomel (mercurous chloride) ointment for a period of at least 3 minutes. The penis is then wrapped in paper or gauze. The subject should not urinate for 4 hours.

REFERENCES

WD Circ. 125. Section VIII. Venereal disease, 30 Mar 1944.
TM 8-220, Medical department soldier's handbook, 5 Mar 1941.

IMMUNIZATION

Classification of immunity.



Passive immunization, the transferral of antibodies from an immune to a susceptible individual, is of limited value in the military service except in such diseases as gas bacillus infections. Active immunization, the generation of antibodies by the injection of a specific antigen into a susceptible individual, is the method of greatest military value.

Handling of biologicals

Storage and Transfer. Smallpox and yellow fever vaccines must be stored and shipped at freezing temperatures or lower, preferably at —10°C. The potency of smallpox vaccine is lost rapidly at 5°C. Yellow fever vaccine should not be used if it has been exposed to room temperature for more than an hour.

Other agents should be stored at temperatures between 2° and 10°C. Lower temperatures may be harmful, because freezing may injure the product or break the container. Higher temperatures may be tolerated for reasonable periods of time because these agents tend to be relatively stable.

Administration. Before injecting any biological, such as vaccines, toxoids, or sera, the existence of sensitivity to the foreign protein must be determined. This is especially true of egg protein in the case of vaccines for typhus, influenza, yellow fever and Rocky Mountain spotted fever which are cultivated in eggs. When the individual gives an allergic history, sensitivity should be tested. If proven, small, frequent, repeated doses of the vaccine, or actual desensitization may be employed.

All immunized subjects should be observed for at least 30 minutes after an injection, since practically all dangerous reactions occur within that period. A solution of 1:1000 epinephrine, injected subcutaneously in doses of 0.3-0.8 cc, is sufficient to control mild reactions. For severe reactions, larger or repeated doses may be used.

When reactions with an immunizing agent are unusually severe or frequent, a report must be made to the Surgeon General. The report should contain the following data: name of the product, maker's name, dosage, lot number, expiration date, which injection in the series produced the reaction, and what kind of reaction was produced. After any dangerous allergic reaction, the agent, date, type, and severity of the reaction must be recorded on the Immunization Register, WD AGO Form 8-117.

Simultaneous Immunization. Yellow fever vaccine should not be given concurrently with smallpox, because the reactions of the two vaccines tend to occur at the same time. Triple typhoid vaccine should not be given within the 7 day period following yellow fever immunization because an exaggerated typhoid reaction may occur, superimposed on the fever produced by the yellow fever vaccine. Otherwise, there are no objections to simultaneous immunizations.

Immunization requirements

All military personnel and all civilians connected with the army in the field are required to be immunized against stated diseases. Civilians who refuse may be restricted to the post. Military personnel may be excused from immunizations only by the commanding officer on the recommendation of the surgeon where definite medical contra-indications exist. A record of immunizations is kept on WD AGO Form 8-117.

Classification of immunization

Immunizations are classified for convenience into three groups: routine, special, and occasional. Routine immunizations are given to all personnel, usually on entrance into service, for duty anywhere. Special immunizations are given to personnel working or likely to be working in hazardous areas. Occasional immunizations are given only when indicated, for specific infections.

REFERENCES

AR 40-210, Prevention and control of communicable diseases of man, 15 Sept 1942.
TB Med 114, Immunization, 9 Nov 1944.
AAF Ltr. 25-15, Immunization for overseas duty, 8 Aug 1944.

SUMMARY OF IMMUNIZATION REQUIREMENTS

ROUTINE

Immunization	Agent & Catalog No.	Required		Initial Series			Stimulating Doses	
		For duty in U.S.	For duty overseas	No. of doses	Individual dose	Recommended interval between doses	When indicated	Amount
Smallpox	Smallpox vaccine (No. 1609000).	Yes	Within 1 yr. (all theaters).	1	Contents 1 capillary tube		Every 3 yrs. and in presence of the disease.	Contents 1 capillary tube
Typhoid-paratyphoid	Triple typhoid vaccine (No. 1730000).	Yes	Within 1 yr. (all theaters).	3	1st dose—0.5cc 2nd dose—1.0cc 3rd dose—1.0cc	7 to 28 days	Annually, and in the presence of the disease*	0.5cc
Tetanus	Tetanus toxoid Nos. 1612500 and 1612700).	Yes	Same as for duty in U.S.	3	1.0cc	Minimum of 21 days	One year after initial series and upon occurrence of wounds or burns, as directed by the medical officer.	1.0cc

*The interval between the three doses of the initial series of triple-typhoid vaccine may be 7 to 28 days. The 0.5 cc stimulating dose should be given only to those who have completed an initial vaccination series with Army triple-typhoid vaccine.

SUMMARY OF IMMUNIZATION REQUIREMENTS

SPECIAL

Immunization	Agent & Catalog No.	Required		Initial Series			Stimulating Doses	
		For duty in U.S.*	For duty overseas	No. of doses	Individual dose	Recommended interval between doses	When indicated	Amount
Typhus (Louseborne)	Typhus vaccine (No. 1612800).	No	Yes, for movement to or through defined endemic areas.	2	1.0cc	7 days	Seasonally about 1 Nov. & 1 Feb. in endemic areas & in presence of the danger of typhus.	1.0cc
Cholera	Cholera vaccine (No. 1601500).	No	Yes, for movement to or through defined endemic areas	2	1st dose—0.5cc 2nd dose—1.0cc	7 days	At 4–6 month intervals in the presence of danger of cholera.	1.0cc
Yellow fever	Yellow fever vaccine (Nos. 1613000 & 1613200).	No	Yes 10 days or more before reaching endemic area).	1	0.5cc of the proper dilution.		Every 4 years	0.5cc of the proper dilution.
Plague	Plague vaccine (No. 1607000).	No	Only on special order or in presence of definite plague hazard.	2	1s dose—0.5cc 2nd dose—1.0cc	7 days	At 6-month intervals in the presence of danger of plague.	1.0cc
Influenza	Influenza vaccine (No. 1605900).	No	No	1	1.0cc			

*All male AAF personnel eligible and physically qualified for overseas duty are required to obtain typhus, cholera, and yellow fever initial immunizations. No stimulating doses of these special vaccines should be given such personnel prior to receipt of orders moving them to AAF staging areas or equivalent.

SUMMARY OF IMMUNIZATION REQUIREMENTS

OCCASIONAL

Immunization	Agent	Indication	No of doses	Individual dose	Interval between doses	Stimulating doses
Diphtheria	Diphtheria toxoid plain (No. 1604100)	Outbreak of diphtheria	4	0.1, 0.5, 1.0, 1.0cc	48 hrs. between 1st and 2d; 3 to 4 weeks for remainder.	Usually none
Scarlet fever	Scarlet fever streptococcus toxin (No. 1608300).	Seldom indicated	5	See directions on pkg.	1 week	None
Rocky Mountain spotted fever	Rocky Mountain spotted fever vaccine (non-standard).	Only for personnel exposed frequently to infected ticks	3	1.0cc	7 to 10 days	Repeat series annually if indicated.
Measles (passive)	Immune serum globulin (human) (No. 1605500).	Prevention or modification in susceptible contacts under special conditions.	1	5 to 10cc within 10 days after exposure.		Usually none
Tetanus (passive)	Tetanus anti-toxin (No. 1611000).	Wounded personnel who have not received initial toxoid series.	1	Not less than 1,500 units.		Usually none.
Rabies	Rabies vaccine (non-standard)	When bitten by rabid animal.	14 or 21*	See directions on package.	1 day	None.

*Rabies vaccine is administered for 14 days when the material used was not prepared according to the technique of Pasteur, and when the wound is elsewhere than on the face. Rabies vaccine is continued for 21 days when the vaccine was prepared according to the technique of Pasteur, and when the wound is on the face.

THE SANITARY SURVEY

A sanitary survey is an analysis of conditions existing in a locality which may influence the health of military personnel. The primary purpose of the survey is to secure accurate data on:

1. The simplest and most effective means of preventing disease.
2. The most rapid and most practical method of controlling disease.
3. How the general health can be improved.

Types

Surveys vary in scope, character, and purpose for which conducted:

A sanitary survey may consist of a *general* or complete study of all the conditions within a command which actually or potentially affect health, or it may be limited in scope and be restricted to the consideration of certain special factors.

A *limited or partial* sanitary survey is usually made for the purpose of controlling or preventing the occurrence of some particular disease or disease group. A survey of a system of water supply may be made, for example, where it would have as its objective the detection and correction of conditions affecting the potability of the water and the control or prevention of intestinal diseases. After apparent adjustment of defects, a limited sanitary survey is frequently indicated later to ascertain the efficacy of the control measures instituted.

One type of partial sanitary survey is the *Epidemiological Study,* made to detect the presence of disease and the factors relating to its incidence and transmissions, as well as to determine the most effective measures for control.

The general sanitary survey

No two sets of conditions which affect the health of military personnel are identical, but all possess certain basic features. In the tactical unit, or in a larger AAF command in the field, the military population differs in certain fundamental respects from a native or civilian population, and the environment of a military organization is usually quite different from that of the surounding native communities. Nevertheless, an airdrome or isolated landing strip is an integral part of the area within which it is situated. Those factors which adversely affect health in the adjacent areas may, if uncontrolled, introduce disease into the military set-up. It is thus evident that a complete sanitary survey cannot be restricted to the AAF unit itself, but must include an accurate appraisal of pertinent sanitary factors in the surrounding communities. A complete survey normally has two distinct sections: the *military* and the *native.*

Conduct of a sanitary survey

The first step in the conduct of any survey is the formulation of a complete and workable *plan* listing the types of information which are to be obtained, the sources from which secured, and the methods to be employed. Such a plan frequently will obviate a needless expenditure of time and effort and will insure accurate information and definitive results.

The information sought in making a sanitary survey is obtained in a variety of ways. That pertaining to strictly military features, such as personnel and mission can be secured from headquarters. In the higher echelons data of this kind are normally derived through the proper staff sections. Good liaison with these officers is essential in the successful conduct of this portion of the sanitary survey.

The environmental conditions within the bivouac or airdrome area must be determined by careful personal inspection and study of the installations and facilities concerned.

There is no suitable substitute for personal reconnaissance in securing accurate data. Certain points are obtainable from existing records. Information pertaining to orders issued and their enforcement are secured by consultation and interview with the responsible officers. It is preferable to make personal observations rather than considering as final the information obtained from others.

The flight surgeon making a sanitary survey must possess practical knowledge of the installations and conditions he inspects in order to properly interpret and appraise his findings. Only in this way can he prepare sound recommendations for the correction of any deficiencies found.

CHECKLIST FOR COMPLETE SANITARY SURVEY

Sanitary survey of a military station

1. General

a. Designation of station.
b. Strength.
c. Mission.
d. Provisions for medical service.

(In a theatre of operations these items are not included in the written report of sanitary survey. They must, however, be taken into cognizance by the flight surgeon performing a sanitary survey so that the over-all sanitation can be better appraised.)

2. Environment.

a. Topographical features — drainage (natural and storm water), rainfall, ground water level, type soil, and vegetation.
b. Housing — tentage, hutments, semipermanent or permanent quarters, general policing, bedding (airing), sleeping on ground, beds (improvised, cots, etc.), heating, ventilation, head-to-foot sleeping, and spacing.
c. Human waste disposal—type latrine, police detail, supervision, flyproofing, location in relation to remainder of camp, and facilities for washing of hands.
d. Animal waste disposal—composting, scattering, oiling and supervision.
e. Garbage disposal—garbage can lids, police of racks, method of disposal, adequacy, care and operations of incinerators, screening of soakage pits, and grease traps.
f. Messing facilities—adequacy of space, protection from weather, and location.
g. Kitchens (see Section 9-8)—adequacy of facilities, police and location of food storage in relation to kitchen.
h. Food—sources, transportation to unit, types of rations, adequacy, menus, storage facilities, protection from insects and vermin, ventilation of storage areas, preparation, food handlers (frequency and adequacy of examination), and serving.
i. Water supply—source, transportation to unit, purification (method, supervision, and testing), method of dispensing, Lyster bags (police, location, and height from the ground).
j. Personal hygiene — bathing facilities (showers, types, improvisations, steam bathing, bathing schedules), and laundry facilities.
k. Recreation—facilities (tents, rooms, hutments), athletics (type program, supervision, participation by all personnel of the command), passes, and leaves.
l. Insect survey—mosquito, fly, and other insects.
m. Environmental factors adversely affecting morale and corrective measures employed.
n. Disease prevalence—undue incidence and control measures.

Sanitary survey of native areas

1. Towns, cities, or villages accessible to troops on pass.

a. Environmental factors—water supply (all native water "off limits"), character of restaurants and other eating places, crowding in theatres, street cars, prevalence and control of insect vectors.
b. Economic conditions.
c. Recreational facilities for troops.
d. Prostitution—laws relating to, and extent of.
e. Prevalence of disease.

2. Rural areas accessible to troops.

a. Economic conditions of the population.
b. Water supplies ("off limits").
c. Terrain—prevalence of mosquito breeding areas.
d. Insect vectors—control.
e. Prevalence of disease—epidemic and endemic diseases, sources of infection.

Report of sanitary survey

After the necessary data has been obtained, a written report should be made promptly in which

all findings are accurately and clearly recorded. A definite outline or plan should be followed in drawing up the report. All recommendations made should be commensurate with the military mission and the facilities at hand. These recommendations may be incorporated in a sanitary order which may be published ultimately as a General Order or Theatre Air Force Regulation in the higher echelons, or as a Memorandum from a lower echelon Headquarters. (For form to be used see FM 21-10.)

Airdrome site selection

The following checklist will be found helpful in the selection of a suitable site for an airdrome:

1. Proximity to native villages or native quarters.
2. Proximity to mosquito breeding areas.

a. Swamps.
b. Stagnant pools.
c. Native wells.
d. Artificial containers.
e. Taro pits.
f. Rice paddies.
g. Bromeliads.
h. Tree stumps.

3. Drainage of area.

a. Natural drainage.
b. Possibilities of artificial drainage.
c. Artificial impounding of water.

4. Ground water level.
5. Presence of insects, vermin, or rodents.

a. Types.
b. Methods of control.

6. Prevailing winds bringing in mosquitoes from distant areas.
7. Character of water supply.

a. Source.
b. Relative status of contamination.
c. Adequacy of supply.
d. Distance water must be transported.

8. Proximity and availability of next echelon of evacuation using existing road net.
9. Natural cover and camouflage.

REFERENCES

FM 21-10, Military sanitation and first aid, 31 Jul 1940.

SANITATION ALOFT

Disposal of waste

For the disposal of urine in flight most aircraft are equipped with a rubber relief tube. If this has been used at any time, the crew chief or a member of the maintenance crew should be so informed in order that it may be properly cleansed in the prescribed manner on returning to the base. In the larger ships, there is a commode. A 5% solution of cresol should cover the bottom of this to a depth of 1 inch. The accumulated contents are to be disposed of after landing by pouring into a latrine or by burial. The bucket is then thoroughly cleaned with a 5% cresol solution and replaced in the aircraft with 5% cresol solution to a depth of 1 inch remaining in the bottom.

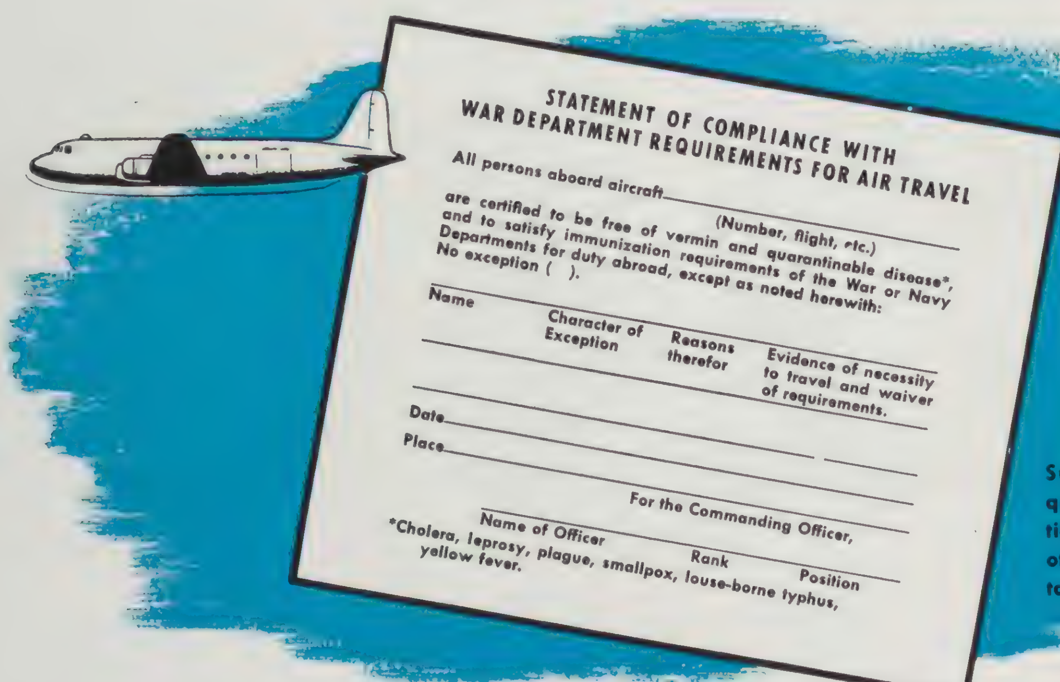
Vomiting aloft may occur. Cardboard ice cream cartons, cellophane sandwich bags, or pliable plastic (pliofilm) cap covers should be available for collecting the vomitus. Disposal of this on return to the base is to be accomplished as for solid wastes.

Quarantine of personnel

Travel in aircraft under the jurisdiction of the army from or to the U. S. will be contingent on the satisfaction of immunization requirements of the War or Navy Department. The pilot of the aircraft will be notified in writing that all persons aboard unless otherwise indicated have met these requirements. It is anticipated that the surgeon at the airport of departure will collect and furnish this data to the operations officer. A suggested form is attached. Quarantinable diseases in aircraft travelling from or to the U. S. are cholera, plague, smallpox, typhus (louse-borne), yellow fever, and leprosy. No person will be transported by air whose last possible contact with pneumonic plague has been within 7 days. All personnel must be free from vermin. It will be the responsibility of the pilot to notify the commanding officer of airfields entered, who will notify the quarantine authorities of the country concerned in accordance with the requirements of that country. The movements of persons will be restricted in accordance with the quarantine regulations of the country concerned.

Quarantine of plants, animals and their products

No animal or plant product likely to convey disease and no living plant or animal will be carried across national boundaries by an airplane under the jurisdiction of the army except upon specific permit. This provision was included in order to prevent the spread of such diseases as rabies and psittacosis, and to avoid the importation of animals that might become pests.



STATEMENT OF COMPLIANCE WITH
WAR DEPARTMENT REQUIREMENTS FOR AIR TRAVEL

All persons aboard aircraft ____________________

(Number, flight, etc.)

are certified to be free of vermin and quarantinable disease*, and to satisfy immunization requirements of the War or Navy Departments for duty abroad, except as noted herewith:

No exception (   ).

Name	Character of Exception	Reasons therefor	Evidence of necessity to travel and waiver of requirements.

Date ____________________

Place ____________________

For the Commanding Officer,

Name of Officer Rank Position

*Cholera, leprosy, plague, smallpox, louse-borne typhus, yellow fever.

Suggested form for required written notification of quarantine status of passenger to be given to pilots of aircraft.

Disinsectization of aircraft

The Aerosol insecticide (QM issue, stock No. 51-1-159) is to be used in accordance with the instructions on the container. All compartments and spaces are to be sprayed, dividing the time recommended in the table proportionately. Spraying is to be carried out immediately before the last take-off prior to the entry concerned. It is to be done by the pilot or under his direction by personnel of the flight crew. It is to be done after full loading and during or prior to the warm up of the engine and with all openings closed during the Aerosol spraying and for at least 2 minutes thereafter. This interval is increased to 5 minutes when the hand sprayer is used. Compartments inaccessible from within the plane will be sprayed as soon as loading of the compartment is completed. Disinsectization will be certified in the clearance of the aircraft (AAF Form No. 23) and will be signalled to the control tower as well. Disinsectization will not be required of aircraft arriving in the U. S., its territories and its possessions from continental U. S., Iceland, Bahama Islands, Curacao and Aruba, Alaska, Greenland, Bermuda, St. Thomas, V.I., Canada and adjacent areas, British Isles, Mexico (Federal District), or Galapagos Islands. All planes will be disinsectized prior to the last take-off before arrival in the territory of Hawaii.

In lieu of Aerosol insecticide, disinsectization may be accomplished by fine vaporization from a hand sprayer with materials which may be obtained from the Quartermaster.

REFERENCE

AAF Reg. 61-3, Flying outside the United States: Quarantine, 9 Aug 1944.

Quarantine laws and regulations of the U. S. and international treaties applicable to international aerial navigation, U. S. Public Health Service, Washington, Government Printing Office, 1942.

Type of Aircraft	Aerosol (Hold 2 min.)	Handspray (Hold 5 min.)
Single-seat planes	3 sec.	3 cc.
B-17, B-25, B-26, C-47, etc.	15 sec.	10 cc.
B-24, C-87, etc.	25 sec.	15 cc.
B-29, C-54, etc.	40 sec.	25 cc.

A watch with second hand will be used by all sprayers.

DISINSECTIZATION WITH THE AEROSOL-PYRETHRUM BOMB. THE AIRCRAFT IS FULLY LOADED AND CLOSED, AND CARGO AS WELL AS FITTINGS AND STRUCTURAL MEMBERS ARE CAREFULLY SPRAYED.

INDUSTRIAL HAZARDS IN AVIATION

Maximal Permissible Concentrations of Atmospheric

Toxic Agents Commonly Found in Aircraft Repair and Maintenance Installations

SUBSTANCE	CONCENTRATION
Acetone	200 p.p.m.
Aliphatic acetates	500 p.p.m.
Ammonia	100 p.p.m.
Amyl acetate(n)	500 p.p.m.
	400 p.p.m.
Aniline	5 p.p.m.
Arsenic trioxide	0.5 mg./cu.m.
Arsine	1 p.p.m.
Benzene	100 p.p.m.
	75—100 p.p.m.
	75 p.p.m.
Bromine	1 p.p.m.
Butanol	100 p.p.m.
Butyl acetate	500 p.p.m.
	400 p.p.m.
Cadmium	0.1 mg./cu.m.
Carbon dioxide	5500 p.p.m.
Caron disulfide	20 p.p.m.
	15 p.p.m.
Carbon monoxide	100 p.p.m.
Carbon tetrachloride	100 p.p.m.
Chlorine	75 p.p.m.
	1 p.p.m.
Chlorodiphenyl	1.0 mg./cu.m.
Chloroform	100 p.p.m.
Chloronaphthalenes	1—5 mg./cu.m.
" (above "tri")	1.0 mg./cu.m.
" ("tri")	5.0 mg./cu.m.
" (penta)	0.5 mg./cu.m.
Chromium (hexavalent)	0.1 mg./cu.m.
Chromium	0.1 mg./cu.m.
Dichlorbenzene	75 p.p.m.
Dichlorethylene (trans)	100 p.p.m.
Dichlorethyl ether	15 p.p.m.
Ethanol	250 p.p.m.
Ethyl bromide	1700 p.p.m.
Ethyl chloride	2000 p.p.m.
Ethyl ether	400 p.p.m.
Ethylene dichloride	100 p.p.m.
Formaldehyde	20 p.p.m.
Gasoline	1000 p.p.m.
Hydrogen chloride	10 p.p.m.
Hydrogen cyanide	20 p.p.m.
Hydrogen fluoride	3 p.p.m.
Hydrogen sulfide	50 p.p.m.
	20 p.p.m.
Iron Oxide fume (Fe^1O^3)	15 mg./cu.m.
Lead	0.15 mg./cu.m.
Magnesium oxide fume	15 mg./cu.m.
Manganese	50 mg./cu.m.
	6 mg./cu.m.
	5 mg./cu.m.
Mercury	0.1-0.2 mg./cu.m.
	0.15 mg./cu.m.
	0.1 mg./cu.m.
Methanol	200 p.p.m.
	100 p.p.m.
Methyl bromide	50 p.p.m.
Methyl chloride	500 p.p.m.
Monochlorbenzene	75 p.p.m.
Naphtha	5000 p.p.m.
Nitrobenzene	5 p.p.m.
	1 p.p.m.
Nitrogen oxides	29-70 p.p.m.
	40 p.p.m.

INDUSTRIAL HAZARDS IN AVIATION (CONTINUED)

SUBSTANCE	CONCENTRATION
	10 p.p.m.
Ozene	1 p.p.m.
	0.1 p.p.m.
Perchlorethylene	100 p.p.m.
Petroleum vapors	1000 p.p.m.
Phosgene	1 p.p.m.
Phosphine	2 p.p.m.
Phosphorus trichloride	0.7 p.p.m.
Sulfur dioxide	10 p.p.m.
Tetrachlorethane	10 p.p.m.
Tetrachlorethylene	200 p.p.m.
Toluene	200 p.p.m.
	100 p.p.m.
Trichlorethylene	200 p.p.m.
	100 p.p.m.
Turpentine	700 p.p.m.
	200 p.p.m.
Xylene	200 p.p.m.
	100 p.p.m.
Zinc oxide fume	15 mg./cu.m.

DUSTS

Millions of particles per cubic foot of air—light field

SUBSTANCE	CONCENTRATION
Alundum	15
Asbestos	15
	5
Carborundum	15
Cement	15
Feldspar	10
Foundry	20
	15
	12
Granite	25
	10
Mica	50
	10
Nuisance	50
Pottery	4
Organic	50
Pyrophyllite talc	25
	10
Silica p (based on percentage of free silica in the dust)	
Count x%	5
10%	50
("low")	50
10%	10
25—35%	10
"medium"	20
"high"	5
over 75%	5
over 90%	5
Silicates	15
Slate	50
	15
Soapstone	50
Talc	50
	15
Total Dust	50

CONTROL OF PRINCIPAL TOXIC AGENTS FOUND IN AAF DEPOTS

PROCESS WHERE FOUND	TOXIC AGENT	HEALTH HAZARDS	CONTROL MEASURES
Aero Repair	Carbon tetrachloride Solvent dry cleaning—(petroleum distillate) Gasoline Small quantities other toxic agents such as benzol, phosgene, toluene, acetone, amyl acetate, lead, ethyl alcohol, butyl alcohol, ethyl acetate, butyl acetate, petroleum naphtha, turpentine, mixture carbon monoxide, caustic cleaners, oils, greases.	Dermatitis Pulmonary edema Kidney and liver damage Poisoning with nervous symptoms Aplastic anemia Inebriation Irritation of eyes and respiratory passages Conjunctivitis Caustic effect Anoxemia	General exhaust or good natural ventilation Local exhaust ventilation for cleaning inside of planes Protective hand creams Strict personal hygiene Good housekeeping Covered solvent containers Isolation of any dope and paint operations
Assembled Engine Cleaning	Rust-preventive (probably vegetable oil butyl alcohol, 3 percent tertiary phenolic amine.) Solvent dry cleaning (petroleum distillate). Kerosene	Dermatitis Acute inebriation Nervous symptoms	Exhaust ventilation (booth) Protective creams and ointments Protective clothing such as gloves, aprons, and boots Strict personal hygiene
Battery	Lead Sulphuric acid Sulphur dioxide	Dermatitis Plumbism Dyspnea Fatigue Sluggishness	Local exhaust ventilation (hood type) Rubber gloves, aprons, and face shields for operators Isolation of process
Blacksmith	Carbon monoxide Sulphur gases Excessive heat	Dermatitis Anoxemia Death Dyspnea Fatigue Sluggishness Heat exhaustion	Local exhaust or good natural ventilation for forge Isolation of process General exhaust ventilation Good housekeeping
Block test	Carbon monoxide Solvent dry cleaning (petroleum distillate) Noise Kerosene, oils, greases	Dermatitis Anoxemia and death Nervous symptoms	Positive pressure ventilation of control room Local exhaust of oil return system Protective hand creams Protective ear plugs Proper design and location of block test buildings
Carburetor and Ignition	Solvent dry cleaning (petroleum distillate) Carbon tetrachloride Small amounts of lead, metallic decomposition of commercial fluxes, hydrochloric acid	Dermatitis Nervous symptoms Plumbism Production of phosgene Injuries of kidneys and liver	General ventilation (exhaust or supplied air type) Covered solvent containers Protective hand creams
Electroplating	Sodium cyanide Cadmium oxide Oxides of nitrogen Hydrofluoric acid Other chemicals which may be used are lead carbonate, copper sulphate, nickel sulphate, nickel chloride, phosphoric acid, acetic acid, caustic soda, chromic acid	Dermatitis Effects of hydrogen cyanide Edema of lungs Caustic effect Plumbism Hemochromatosis Conjunctivitis Chrome ulcers	Local exhaust ventilation (horizontal slot type preferable) General exhaust ventilation Isolation of process Gloves, aprons, face shields, and goggles, for operators Low temperature of solution and reduced rate of operations of process in absence of ventilation Protective nasal ointments

PROCESS WHERE FOUND	TOXIC AGENT	HEALTH HAZARDS	CONTROL MEASURES
Engine Cleaning	Carbon tetrachloride Turco fuzee (80 percent ethylene dichloride 20 per cent cresol) Mixture (50 percent carbon tetrachloride 50 percent gasoline) Solvent dry cleaning (petroleum distillate) Caustic cleaners (soda, ash, Oakite) Other solvents such as gasoline and turpentine	Dermatitis Effects liver and kidneys Edema of lungs Acute narcotic effect Nervous symptoms Conjunctivitis Nephritis	Local exhaust ventilation (horizontal slot type) and good natural ventilation Strict personal hygiene Protective creams and ointments Protective clothing Use of lanolin oil hand cleanser Isolation of process
Engine Disassembly	Carbon tetrachloride Mixture of 50 percent carbon tetrachloride 50 percent gasoline Solvent dry cleaning commercial petroleum distillate Oils, greases Other volatile solvents	Dermatitis Nervous symptoms	Local exhaust (lateral type) or good natural ventilation Strict personal hygiene, protective clothing, protective ointments and creams, and use of lanolin oil hand cleanser
Foundry	Silica Carbon monoxide Metal fumes Excessive heat	Silicosis Anoxemia and death Heat exhaustion Fume fever	General exhaust ventilation Approved type dust respirators Good housekeeping Use of nonsilica parting compound
Heat Treating	Sodium cyanide Carbon monoxide	Dermatitis Effects of hydrogen cyanide Anoxemia and death	General exhaust ventilation Individual exhaust pipe for cyanide Strict personal hygiene
Hydraulic	Carbon tetrachloride Solvent dry cleaning (petroleum distillate) Mixture 50 percent carbon tetrachloride and 50 percent kerosene Benzene Alcohol Carbon black	Dermatitis Liver and kidney damage Nervous symptoms Aplastic anemia Atrophy of optic nerve Anthracosis Inebriation	General exhaust ventilation or good natural ventilation Local exhaust ventilation for continuous cleaning operations Covered solvent containers Protective creams and ointments Strict personal hygiene Use of gloves where possible
Instrument Repair	Mixture of 50 percent carbon tetrachloride, 50 percent gasoline Stoddard's solvent (commercial organic solvent) Solvent dry cleaning (petroleum distillate) Other toxic agents such as ammonia, alcohol, miscellaneous organic solvents	Dermatitis Liver and kidney damage Nervous symptoms Acute inebriation	Properly designed ventilated spray booth for cleaning Covered solvent containers Protective creams and ointments
Luminous Dial Repair	Radioactive luminous paint Radon Gamma radiation	Burn from gamma radiation Radium poisoning	Special designed workroom equipped with argon light inspection room, approved hoods, and exhaust ventilation Compulsory personal hygiene Proper storage and handling of luminous compound Good housekeeping Dry paint removal under liquid or ventilated hood and operator provided with approved supplied air respirator

PROCESS WHERE FOUND	TOXIC AGENT	HEALTH HAZARDS	CONTROL MEASURES
Machine Shop	Cutting oils and greases Synthetic resin and asbestos dust	Dermatitis Asbestosis	Strict personal hygiene Protective creams and ointments Local exhaust ventilation of dusty processes
Minor Repair	Carbon tetrachloride Solvent dry cleaning (petroleum distillate) Mixture 50 percent carbon tetrachloride, 50 percent gasoline Small quantities other toxic agents such as benzol, gasoline, toluene, acetone, amyl acetate, lead, ethyl alcohol, butyl alcohol, ethyl acetate, butyl acetate, petroleum naphtha, turpentine, caustic cleaners, oils, and greases	Dermatitis Kidney and liver damage Nervous symptoms Aplastic anemia Narcotic action Conjunctivitis	General exhaust or good natural ventilation Local exhaust ventilation, for cleaning inside of planes Protective hand cream Strict personal hygiene Good housekeeping Other measures are covered solvent containers and isolation of paint and dope operations
Paint and Dope	Benzol Toluene Acetone Amyl acetate Lead paint Other toxic agents such as ethyl alcohol, butyl alcohol, ethyl acetate, butyl acetate, petroleum naphtha, turpentine	Dermatitis Inebriation Aplastic anemia Narcotic action may produce death Plumbism Blood changes Nervous symptoms	Local exhaust ventilation (booth) Approved air-line respirator Approved chemical cartridge-type respirator Closed solvent containers and separate storage of bulk solvents Isolation of process
Plexiglas	Small quantities ethylene dichloride and monomeric methyl methacrylate	Dermatitis Acute anesthetic action	General exhaust or good natural ventilation Covered solvent containers
Propeller	Trichloroethylene Carbon tetrachloride Solvent dry cleaning (petroleum distillate) Small amounts of oils and greases	Dermatitis Acute narcotic poison May form phosgene Lesions of optic and trigeminal nerves Nervous symptoms Kidney and liver damage	Local exhaust ventilation (horizontal slot type) Protective hand creams Strict personal hygiene and use of gloves where possible Lower temperature of solvent and reduce rate of operation
Radiator and Tank	Lead Ultraviolet radiations Gasoline Carbon monoxide Caustic cleaning solutions (soda ash) Other toxic agents such as metal fumes, hydrochloric acid, gaseous decomposition of rod coatings	Dermatitis Plumbism Flash burn of the eyes Nervous symptoms Anoxemia and death Conjunctivitis Metal fume fever Production of phosgene	Local exhaust, ventilation (hood type) General exhaust ventilation Goggles (gas weld) Protective hand creams
Rubber Tank Repair	Benzol Ethylene dichloride Toluene Gasoline Other toxic agents such as ethyl acetate, ethyl alcohol, methyl ethyl ketone, petroleum naphtha	Dermatitis Aplastic anemia Inebriation Narcotic effect Nervous symptoms Irritation of eyes Liver and kidney damage Acute anesthetic action	General exhaust ventilation Local exhaust ventilation or blow (tanks) Covered solvent containers Segregation of process Other measures are strict personal hygiene, protective clothing, protective ointments and creams

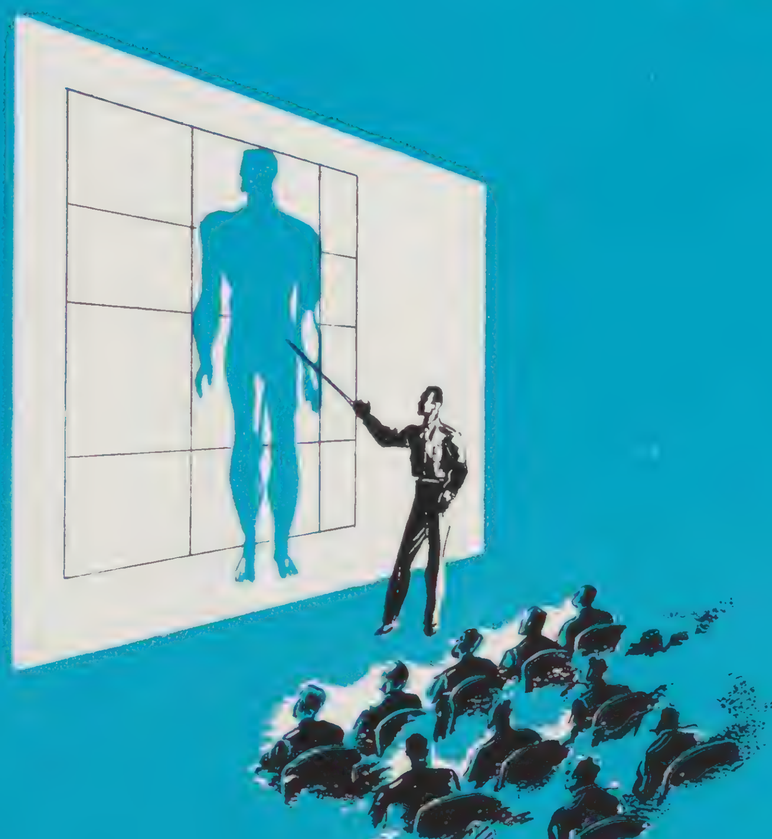
PROCESS WHERE FOUND	TOXIC AGENT	HEALTH HAZARDS	CONTROL MEASURES
Sandblasting	Silica	Dermatitis Pneumoconiosis	Commercial cabinet of proper design Substitution of steel grit for sand Approved-type dust respirator (temporary operations) Approved-type air-line respirator Rubber gloves and aprons Isolation of process Good housekeeping and maintenance of equipment
Spark Plug Cleaning	Silica Carbon terachloride Solvent dry cleaning (petroleum distillate)	Dermatitis Silicosis Liver and kidney damage Acute anesthetic action Nervous symptoms	Local exhaust ventilation Approved-type air-line respirators Approved-type dust respirator Isolation of process Substitution of nontoxic materials
Spray Painting	Lead Toluene Xylene Turpentine Mineral spirits Naphthenate Metallic paint pigments Thinners such as ethyl alcohol, butyl alcohol, amyl acetate, butyl acetate, ethyl acetate, petroleum naphtha, and sometimes benzene	Dermatitis Plumbism Narcotic action Nephritis Acute anesthetic action Renal and hepatic degeneration Aplastic anemia Inebriation	Water curtain spray booth properly ventilated Approved-type chemical cartridge respirator for temporary operations Isolation of process Bulk solvents stored separately
Trichloroethylene Degreasing	Trichloroethylene	Dermatitis Acute narcotic poison Lesions of optic and trigeminal nerves	Local exhaust (horizontal slot type) ventilation Proper installation and operation of commercial degreasers Use of gloves and protective creams Reduce solvent level and rate of operation Keep lid of tank closed as much as possible Approved-type air-line respirator for cleaning pumps Observe all precautions as recommended by manufacturer of equipment Isolation of process
Typewriter	Naphtha Benzene Carbon tetrachloride Kerosene	Dermatitis Acute narcosis Kidney and liver damage Aplastic anemia Inebriation Nervous symptoms	Local exhaust ventilation Isolation of process Protective clothing Protective creams and ointments
Welding	Ultraviolet and infrared radiations Metal fumes Gaseous decomposition of rod coating Excessive heat Fluorides (when welding monel) Other toxic substances are possible, such as oxides of nitrogen, and carbon monoxide	Dermatitis Flash burns of eyes Metal fume fever Heat exhaustion Edema of lungs Anoxemia and death	Protective helmet, shield, gloves, and apron (electric weld) Isolation of process General or local exhaust ventilation Portable or permanent black shield to protect adjacent workers

REFERENCES

Industrial hygiene manual, Patterson Field, Fairfield, Ohio, The Surgeon, Air Service Command.

Industrial hygiene manual, supplement 1, Patterson Field, Fairfield, Ohio, The Surgeon, Air Service Command.

SECTION 10



TRAINING

SECTION 10

TRAINING

PRINCIPLES OF MEDICAL TRAINING

Medical training is divided into two broad fields:

1. The education of the officers and enlisted men and women of the *medical* service to provide them with a thorough knowledge of the principles and methods of military sanitation, field medicine and surgery, logistics, administration, and aviation medicine so that they may efficiently perform their assigned duties.

2. The education of *non-medical* personnel of the AAF (particularly officers and non-commissioned officers responsible for maintaining the health of their commands) in first aid, sanitation and preventive medicine, so that they may protect and care for themselves when medical attendance is not available.

The Altitude Training Program, a Medical Department function, provides additional training for personnel who must engage in frequent and regular flight.

The medical service is responsible for training all Medical Department personnel and assisting organizational commanders by lending technical assistance in the medical training of AAF personnel.

Objectives

One of the primary duties of an army officer is to train the personnel under his command; accordingly every medical officer is responsible for the training of all personnel under his immediate supervision. The objectives of medical training are to:

1. Prepare men as quickly as possible for immediate assignments.
2. Train each individual to fit into the organization.
3. Develop efficient work habits.
4. Prepare soldiers for advancement and greater responsibility.

To attain these objectives the medical officer must:

1. Know thoroughly the subject he is to teach and be able to separate non-essential content from the whole subject.
2. Develop a progressive training plan. Every effort must be made to appreciate the limitations of the student with regard to medical knowledge and to connect new material with the past experience.
3. Know thoroughly the standards of performance that are required of each individual and for each job in order that training may be aimed at a definite goal.

Methods of training

Modern concepts of education indicate that learning progresses most rapidly when the "task performance," and "on-the-job" methods are utilized under the immediate supervision of a responsible individual. The next most efficient method is the combination of training aids (including visual aids) and informal explanatory lectures. The least efficient method is the didactic lecture. When large groups are receiving instruction in the same subject it is not always possible to utilize the "coach and pupil" method of training; therefore, many training aids in the form of training films, film strips, graphic portfolios, posters, and improvised mock-ups have been prepared to increase the efficiency of troop training. Training aids should never be employed alone, but always accompanied by explanatory lectures and question and answer periods. Field Manuals 21-6, 21-7 and 21-8 are catalogues of training literature and pictorial training aids available to each echelon of command. When a training program shows a need for material that is not available locally, the training aid may be requisitioned by forwarding complete catalogue numbers and titles on AAF Form 104-B, through command channels to the Training Aids Division, One Park Avenue, New York City 16, New York. In overseas theatres training film libraries are maintained by each air force headquarters.

REFERENCES

AAF Reg. 50-28, Medical training of AAF personnel and military training of medical personnel, 1 Aug 1944.
FM 21-6, List of publications for training, 23 Dec 1944.
FM 21-7, List of training films, film strips, and film bulletins, 1 Jan 1944.
FM 21-8, Military training aids, 14 Feb 1944.

TRAINING OF MEDICAL DEPARTMENT PERSONNEL

Enlisted

Basic and Technical Training. With few exceptions Medical Department enlisted personnel, including WACs, have received only basic military training when first assigned to AAF hospitals. Thus each AAF hospital functions as a basic Medical Department school and as a school for all categories of Medical Department enlisted specialists. To provide standardized guides for the training of all Medical Department enlisted personnel the following AAF training standards have been prepared:

AAF Training Standard 110-1-1 establishes the general operating procedures for AAF medical units and for the medical sections of AAF tactical units. Senior medical officers of units are required to instruct enlisted personnel in the field aspects of the individual enlisted military occupational specialty and to coordinate this training with unit or combined training.

MILITARY OCCUPATIONAL SPECIALTY	TRAINING STANDARD
Medical corpsman	T. S. 80-657
Medical technician	T. S. 80-409
Medical laboratory technician	T. S. 80-858
Surgical technician	T. S. 80-861
Sanitary technician	T. S. 80-196
Radiology technician	T. S. 80-264
Dental laboratory technician	T. S. 80-067
Orthopedic mechanic	T. S. 80-366
Pharmacy technician	T. S. 80-859
Optician	T. S. 80-365
Medical supply technician	T. S. 80-825
Medical administrative specialist	T. S. 80-673
Meat and dairy inspector	T. S. 80-120

AAF Regulation 50-28 requires that training programs be prepared to assure that the standards of proficiency set forth in the respective Training Standards are attained prior to classification in a particular military occupational specialty. The regulation further requires that the applicatory method of training be employed to assure that each pupil receives practical, supervised instruction in all aspects of his military occupational specialty.

Tactical Training. Because duty in an AAF hospital in the continental United States does not adequately prepare an enlisted man for duty in a theater of operations with a tactical unit, before being assigned overseas as replacements enlisted personnel are sent to the AAF Medical Service Training School (see Section 2-6) where they receive instruction in the field aspects of their specialties and are given intensive training relating to duty overseas.

Commissioned

Officers commissioned in the Medical Department receive basic military training for officers in ASF Schools. After assignment to a hospital or unit, officers continue on-the-job training, professional and military, in order to attain proficiency as outlined in Training Standards 110-1-1 and 110-2. Further training is given to selected officers at the AAF School of Aviation Medicine, at the AAF School, and in some instances at ASF Schools (see Section 2-5).

REFERENCES

AAF Reg. 50-28, Medical training of AAF personnel and military training of medical personnel, 1 Aug 1944.

AAF T.S. 110-1-1, Training for units and individuals of the medical department of the AAF, 26 Aug 1944.

AAF Ltr. 50-66, Training of medical department soldiers, 21 Nov 1944.

AAF T.S. 110-2, Medical training for all AAF units and individuals 16 Mar 1944.

MEDICAL TRAINING OF AAF PERSONNEL

The general policy governing the operations and procedures applicable to medical training are set forth in AAF Regulation 50-28. This regulation provides that the commanding officer of each AAF unit is responsible for the medical training of unit personnel and the unit medical officer is responsible for all aspects of the technical supervision of such training. AAF Training Standard 110-2 sets forth the proficiency requirements in medical subjects and contains a detailed bibliography applicable to the medical training. Because of the varied lengths of time required to train each category of AAF officer and enlisted man it has been found impractical to give all medical training during any one phase. War Department directives require that officers and non-commissioned officers have a more complete knowledge of medical subjects than is required of privates. To coordinate medical training with the various phases of AAF training AAF Letter 50-16 establishes courses of instruction in the basic, or initial, training period, in the advanced training period, in the operational training period, and in the period immediately preceding shipment overseas.

The altitude training program

Establishment and Function. The Altitude Training Program was established by AAF Regulation 50-18. Its primary function is to familiarize flying personnel with the physical conditions and physiological stresses encountered in military aviation in order that they may meet those hazards intelligently and effectively. Functions subsidiary to this are the medical evaluation of flying personnel as regards their responses to simulated high altitudes and collecting data and conducting research relating to the human factors in aviation.

Organization and Personnel. A number of altitude training units have been activated in certain of the overseas air forces. Such units operate under the supervision of a director, appointed by the commanding officer of the station upon recommendation of the surgeon. In the continental commands and air forces operating under manning tables, the personnel conducting the Altitude Training Program constitute, or are assigned to, a section of the AAF base unit at each base. A chief of altitude training, appointed by the station commander upon recommendation of the surgeon, directs the Altitude Training Program at each base.

Before being assigned duties in the Altitude Training Program, enlisted men receive thorough on-the-job training which qualifies them for the Military Occupational Specialty of altitude chamber technician (SSN 617).

The number of personnel assigned to the Altitude Training Program at a base varies with the number of individuals to be indoctrinated and with the number of altitude chambers in operation. Tables of Organization in overseas theaters provide for 3 officers and 25 enlisted men for altitude training units operating one altitude chamber. Approximately similar provisions have been made in manning tables in the continental U. S. In general, if 2 altitude chambers are in operation at a base, 5 officers and 45 to 50 enlisted men will be required, while 4 chambers will require 10 officers and 90 to 100 enlisted men. Variations in the flow of trainees to be indoctrinated may result in variations from these requirements. The critical factor determining the number of enlisted men required is the necessity of avoiding ill effects resulting from too frequent exposure to simulated high altitudes in the low pressure chamber. In general, men should not be required to participate in altitude chamber flights more often than every other day. Variations in the capacity of the chamber used will affect the number of personnel required to indoctrinate a given number of trainees; a smaller chamber requires more men because it will have to make more flights. A fluctuating flow of trainees also tends to increase the number of personnel required.

Operation. Altitude indoctrination of aircrew trainees extends through both the individual and unit training periods. AAF Training Standard 110-2 outlines the standards of proficiency to be attained by such indoctrination. These standards of proficiency are achieved through lectures, demonstrations, discussions, training films and simulated flights in the altitude chamber.

In the AAF Training Command altitude chambers are in operation in preflight schools for pilots, bombardiers, and navigators and in flexible gunnery schools. Nine hours are allotted for altitude indoctrination in these schools. This indoctrination must include two flights in the altitude chamber (Flight types 1 and 2). The remainder of the allotted time is spent in a manner which, in the judgment of the chief of altitude training, will best insure that the trainees attain the desired standards of proficiency. The Type 1 flight is devoted largely to a demonstration of the effects of anoxia. The maximum altitude

reached is 30,000 feet. In the Type 2 flight emphasis is placed upon the use of current types of oxygen equipment; a maximum altitude of 38,000 feet is attained.

In the *unit training* period 6 hours are devoted to altitude indoctrination at the Operational Training Unit or Combat Crew Training School, or in some cases at the replacement pool. Altitude chambers are in operation at various bases in the First, Second, Third, and Fourth Air Forces and in the Air Transport Command. The indoctrination must include one altitude chamber flight and such other instructional procedures as are found necessary for the required standards of proficiency. In the altitude chamber flight (Type 3) personnel are, if possible, indoctrinated as crews, and emphasis is placed upon practical problems of operational flying. Every effort is made to vary the instruction to meet the needs of the particular personnel involved.

Records. It is the responsibility of the chief of altitude training at each station concerned to record on the AAF Form 206 (see Section 5-2) the type of flight, the date it was accomplished, and the station of each individual indoctrinated. Additional records and reports are required by pertinent AAF publications.

Use of the Altitude Chamber in the Physical Evaluation of Flying Personnel. Although the Altitude Training Program is primarily an indoctrination program, the reaction of an individual to a simulated flight in the altitude chamber should be regarded by the flight surgeon as significant evidence bearing upon his fitness for flying duty. Much useful information frequently can be obtained by planning special altitude chamber flights for the investigation of individual cases. The altitude chamber has proved particularly useful in the study of aero-otitis and aerosinusitis, in detecting unusual susceptibility to the various stresses encountered at high altitudes, in distinguishing between organic and psychic factors in the responses of individuals to flying stresses, in the detection of malingering, and in the estimation of the significance of various physical defects under conditions simulating flight. In certain cases, the usefulness of the chamber is enhanced by the fact that the altimeter may be removed or it may be manually controlled, thus keeping the subject in ignorance of his simulated altitude. It has not become routine to determine susceptibility to decompression sickness, but the altitude chamber offers an effective means of doing this when necessary (see Section 7).

Supervision and Control. AAF Regulation 50-18 assigns to the Air Surgeon the responsibility for the direction of the Altitude Training Program, including the supervision of the assignment of aviation physiologists. The regulation further states that directives relative to this program will be coordinated with the Assistant Chief of Air Staff Training.

At individual bases, the director of operations and training or comparable staff officer will establish the training policy and exercise general control and general supervision of the Altitude Training Program, while the surgeon will be responsible for its technical supervision.

Personal equipment training

Relationship to Personal Equipment Program. The development of the Personal Equipment Program in the continental air forces and commands has necessitated close coordination with the Altitude Training Program. The exact means of accomplishing such integration has varied among individual air forces and commands. Most aviation physiologists have been trained also as personal equipment officers. At some bases the two programs have been completely combined under the direction of one officer serving both as chief of altitude training and as base personal equipment officer. A number of aviation physiologists have been released from assignment to the Altitude Training Program in order to serve as personal equipment officers.

REFERENCES

AAF Reg. 50-18, Altitude training program, 3 Oct 1944.

AAF Reg. 50-28, Medical training of AAF personnel and military training of medical personnel, 1 Aug 1944.

AAF Reg. 55-7, Personal equipment officer, 28 Oct 1943.

AAF Reg. 55-7A, Personal equipment officer, 4 Mar 1944.

AAF T.S. 110-2, Medical training for all AAF units and individuals, 16 Mar 1944.

AAF Ltr. 50-28, Instructions governing the altitude training program, 3 Oct 1944.

AAF Ltr. 25-8, Altitude limitations of flying personnel, 23 May 1944.

AAF Ltr. 55-20, Relationship of personal equipment officer to altitude training program, 28 Jul 1944.

AAF Ltr. 50-16, Medical training, 10 Mar 1944.

AAF Ltr. 50-18, Minimum military training requirements for AAF enlisted personnel, 11 Apr 1944.

AAF Ltr. 50-56, Advanced first aid training for selected AAF personnel, 7 Oct 1944.

AAF CONVALESCENT TRAINING PROGRAM

The Convalescent Training Program has the double purpose of physically reconditioning sick soldiers with a course of graduated exercises and turning convalescent time to good use with a carefully planned educational program.

Administration

In each AAF station and regional hospital there is a Convalescent Training Program directed by a convalescent training officer. The program is under the jurisdiction of the base surgeon who establishes the training policy and exercises general control and supervision of training. Each convalescent patient completing a course of instruction totaling 20 hours or more is given a Statement of Accomplishment, a copy of which is sent to the patient's commanding officer. A monthly report of the program is submitted by each base surgeon through channels to the Air Surgeon on a form furnished by the Office of the Air Surgeon.

Personnel

In each air force and independent command there is a qualified Medical Corps or Medical Administrative Corps officer who acts as a full time chief of convalescent training. In each AAF regional and station hospital there is a qualified convalescent training officer who may be of the Medical Corps, Medical Administrative Corps, or Air Corps. When the convalescent training officer is not a member of the Medical Corps, a Medical Corps officer is appointed to act as medical consultant to the program. In addition to the convalescent training officer, other officers, primarily vocational and educational guidance officers and physical fitness officers, and enlisted personnel, primarily medical administrative specialists, clerks, athletic instructors and technical instructors, are authorized.

The convalescent training officer maintains close liaison with the AAF base unit special service officer, the chaplain, representatives of the Red Cross, the public relations officer, and other people useful to the program.

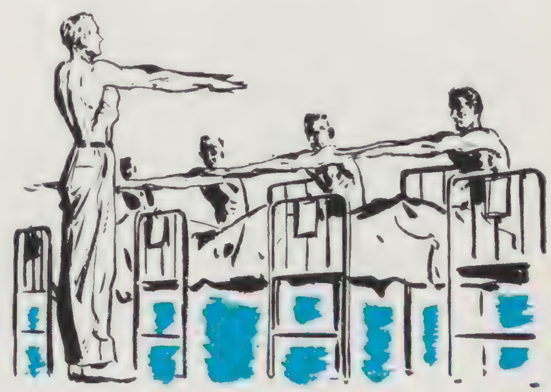
Policy

The general policies encompass the following:

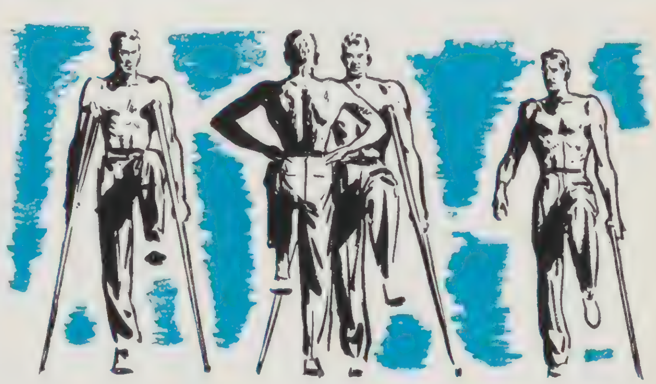
1. Each patient will be treated as an individual.
2. All training will be functional. The Convalescent Training Program will be keyed to other training programs on the base and include variations to meet individual needs and abilities.
3. Training should be started as soon as possible following surgery or the acute stage of illness and should be progressive until discharge.
4. Routine convalescent furloughs will not be given.

Physical training

Physical training is started at the earliest possible moment. Patients are divided into four classes on an ascending scale of activity. Initial placement and subsequent progressions are made solely on the recommendation of the patient's medical officer in charge. The following classification is followed:



1. Group IV or Red: Those patients who are still in bed but are able to perform mild reconditioning exercises.



2. Group III or Yellow: Those patients who need corrective exercise and adaptive sports for specific disabilities.

3. Group II or Blue: Those patients who can participate in general reconditioning exercises and sports stepped down in strenuousness and length of performance.

4. Group I or Green: Those patients who participate in rigorous calisthenics, drill, marches, hikes and vigorous athletics prior to discharge.

Patients take the standard AAF Physical Fitness Test before discharge to duty status (see Section 10-5).

Supplies and equipment

Educational training materials of military, general and shop nature are obtained from the following sources:

1. Field and technical manuals, graphic training aids, special training aids and manuals for illiterates and general educational materials are obtained from the nearest Adjutant General Supply Depot by requisition through normal channels.

2. Training aids for basic military subjects are obtained through base plans and training officer, base camouflage officer, base chemical warfare officer, and base ordnance officer.

3. AAF training aids, posters, pamphlets, training films and film strips are obtained from Training Aids Division Headquarters, AAF, through the Office of the Air Surgeon, in accordance with AAF Regulation 50-19.

4. Educational manuals, textbooks and general educational materials are obtained from United States Armed Forces Institute, Madison, Wisconsin.

5. Materials for orientation and group discussion are obtained through base special services officer, base orientation officer and Education and Information Branch, Morale Services Division, Army Service Forces.

6. Supplies and equipment for basic shops are obtained through normal AAF supply channels in accordance with AAF Ltr 65-36, dated 13 September 1944.

7. Materials obtainable by direct request to the Office of the Air Surgeon are:

YOU ARE CONVALESCING, a pamphlet designed to orient the soldier-patient to the program.

HANDBOOK OF RECOVERY, AAF Manual No. 23, a guide to physical rehabilitation for the patient with an orthopedic disability.

INSTRUCTOR'S GUIDE for the use of HANDBOOK OF RECOVERY.

SIT DOWN AND PLAY, a booklet teaching piano for the patient in need of activities for regaining finger dexterity.

LET'S WALK, a handbook of walking with prosthetic devices.

MONTHLY INFORMATION LETTER, a monthly publication giving a summary and interpretative comment on directives, policy, philosophy, procurement methods and an exchange of ideas on the program.

Miscellaneous printed and mimeographed pamphlets, directives, memoranda, and reports produced in the field and distributed for informational purposes.

REFERENCES

AAF Reg. No. 50-28, Medical training of AAF personnel and military training of medical personnel, 1 Aug 1944.

AAF Reg. 25-17, Medical administration of AAF hospitals, convalescent centers, and dispensaries in continental United States, 7 Feb 1944.

WD Circ. 140, Hospitalization and evacuation of personnel in the zone of the interior, 11 Apr 1944.

AAF Memo. 25-9, Convalescent training program for patients in AAF regional and station hospitals, 16 Jun 1944.

AAF Memo. 20-12, Army Air Forces convalescent centers, 18 Sept 1943.

AF Ltr. 35-42, Assignment of personnel re convalescent-rehabilitation training program, 13 Jan 1944.

AAF Ltr. 65-36, Supplies and equipment for AAF convalescent training program, 13 Sept 1944.

Office of the Air Surgeon, Convalescent training program information letter, published monthly since 1 May 1943.

AAF PHYSICAL TRAINING PROGRAM

AAF physical fitness test

One short battery of tests of physical fitness is used for all AAF personnel. This battery consists of three items: situps, chinning, and a 300-yard shuttle-run. From the scores made in each item a combined score, called the Physical Fitness Rating (PFR), is obtained. This combination of tests, known as the AAF Physical Fitness Test, measures the strength and endurance of large important muscle groups, and endurance and agility in running.

Personnel tested and frequency

The AAF Physical Fitness Test is administered to flying and non-flying personnel 4 times a year. Command and air force headquarters may provide additional testing dates if advisable.

Exceptions are as follows: (1) AAF personnel permanently disqualified for overseas service do not

take the test; (2) persons with medically certified handicaps and men 40 years of age and over (38 years in the Training Command) may be excused from the test by the surgeon or the flight surgeon.

Physical training requirements

In general, the minimum requirement for participation in the AAF physical training program for officers and enlisted men is 3 hours per week unless otherwise specified; at ports of embarkation, staging areas, and enroute to combat theaters, 4 hours per week; and for all students (officers and enlisted men), 15 hours in Basic Training Centers and 6 hours in all other installations. AAF personnel, whose duty assignment is instructor and who hold a military aeronautical rating, and all whose duty assignment involves active outdoor work for approximately 8 hours per day, will be exempt from participating in the physical fitness program for 30 days if they can make a PFR score of 55 or above on the AAF Physical Fitness test.

All officers, exclusive of those whose duty requires outdoor work, are given half a day off each week for outdoor exercises. This does not excuse the officers from their regular physical training period.

Nature of physical training

The official directives offer a large variety of physical activities, including calisthenics, games, tumbling, obstacle courses, cross-country running, athletics, and swimming. A physical instructor is allowed a great deal of initiative and freedom in selection.

No physical training session is complete without running activities, used as such or disguised in the form of games. It is also imperative to develop skills in games. There are two reasons for this: (1) the developmental value during war; (2) recreational value during the period of demobilization. There will be plenty of leisure time, and natural restlessness will develop. Sports and games will provide recreative outlets which will counteract the boredom of waiting for a discharge.

Physical training for convalescents

(see Section 10-4)

Tests of physical fitness of convalescents

In assigning a medical patient to some sort of physical activity it is important to know when the patient can begin exercise and what is safe for the patient to undertake. Tests have been devised to aid the medical officer in determining when the convalescent is ready to begin the various programs. One of these tests, *the red test,* is used to decide when the patient can participate in the red program. This test consists of stepping up on a 20-inch bench 12 times in 30 seconds. The sitting pulse rate is taken for 30 seconds one minute after exercise and if the pulse rate is less than 100 per minute the patient passes the test.

The day after the patient passes the red test, if the ward officer consents, he is given a more strenuous step-up test, called *the progressive test.* This test consists of stepping up on the same 20-inch bench at the rate of 24 steps per minute to the limit of the patient's endurance but not to exceed 5 minutes. The sitting pulse rate is taken for 30 seconds, beginning one minute after exercise. A score is based on the pulse rate and the duration of exercise. Depending on his score, the patient is allowed to enter either the blue program or the green program.

In order to determine when the patient can be discharged from the hospital, the *Harvard test* may be used. This test is the same as the progressive test except that the rate of stepping up and down on the bench is 30 steps per minute instead of 24. A score of 50-80 indicates a satisfactory response.

The importance of rest for convalescents is still given its due, but it is now realized that a reduction in the traditional length of the rest period and the addition of physical training is beneficial to the patient. The use of the testing and the physical training program reduces the number of days of hospitalization and prepares the patient to assume full duty upon his discharge from the hospital.

REFERENCES

AAF Reg. 50-10, Physical fitness test, 3 Feb 1944.
AAF Reg. 50-10A, Physical fitness test, 4 Apr 1944.
AAF Reg. 50-14, Physical training, 6 Jul 1944.
TC Memo. 50-21-6, Physical fitness test, 8 Aug 1944.
AAF Reg. 50-14, Physical training, 6 July 1944.
Karpovich, P. V.: Physical fitness for convalescents, AAFSAM Project 224, Report 1, 14 June 1944.
Weiss, R. A., Physical training program for convalescent medical patients, AAFSAM Project 246, Report 1, 13 July 1944.
Karpovich, P. V., Starr, M. P., Weiss, R. A.: Physical fitness test for convalescents, J.A.M.A., 126:873, 1944.
AR 605-110, Commissioned officers, maintenance of and tests for physical fitness, 28 Dec 1938, C1, 21 Dec 1942.

SECTION 11

RESEARCH AND REFERENCES

SECTION 11

RESEARCH AND REFERENCES

MEDICAL RESEARCH IN THE AAF

Classification

Medical research in the AAF is divided for convenience' sake into 3 general categories:

A. *Clinical*—concerned with:

1. Selection of flying personnel.

a. Improvement of the physical standards for flying.

b. Development of tests of aptitude and proficiency for duties in the military aircraft.

2. Maintenance of flying personnel.

a. Evaluation of factors affecting physical and mental health of the flyer, especially preventive factors.

b. Study of problems relative to convalescence and rehabilitation of the sick airman.

c. Study of evacuation of patients by aircraft.

d. Creation of a physical fitness program.

B. *Fundamental*—concerned with basic medical investigation from which practical procedures and equipment may be developed.

C. *Technological*—concerned with medical problems in relation to AAF materiel, engineering advances, and operations.

Mission

The program of medical research in the AAF is designed to determine what data is necessary to improve the health, efficiency, and endurance of AAF personnel; to collect such data; and to distribute it for application. The specific aims of this program are to:

1. Expand the knowledge of all branches of medicine with special reference to the problems of the flyer.

2. Determine the necessary qualifications of individuals for the various categories of flying.

3. Discover and define the human limitations in flying, and to develop methods to surmount these.

Responsibility

Medical research in the AAF is coordinated and technically supervised by the Air Surgeon.

Every medical officer is expected to maintain an attitude of continuous observation and investigation concerning AAF medical problems. However, certain organizations have been established specifically to carry out research projects. Some of these are:

1. AAF School of Aviation Medicine (see Section 2-5), conducts research on the selection, classification and care of AAF personnel. Fundamental problems relating to the reactions of the human body to flight are studied. Research is principally clinical and fundamental as defined above.

2. Aero Medical Laboratory, AAF Air Technical Service Command (see Section 2-5) conducts research on the development and evaluation of equipment dealing with the comfort, safety and efficiency of personnel and the design and construction of items of medical equipment peculiar to the AAF. Research is principally technological.

3. The Physiological Projects Section, AAF Proving Ground Command (see Section 2-6) is devoted almost exclusively to the evaluation of the tactical and functional adequacy of materiel from a physiological standpoint and is concerned, therefore, primarily with technological research.

4. Altitude Training Units (see Sections 1-4 and 10-3) devote some time to collecting and evaluating physiological data and to appraising equipment.

5. Psychological Research Units (see Sections 1-5 and 7-5) have been established to devise and validate tests of aptitude and proficiency both in the zone of interior and in theaters of operation.

6. Central Medical Establishments (see Section 2-6) conduct research on problems concerning personnel and equipment of the air force or command to which they are assigned.

Research reports

In order that the AAF benefit from research being conducted by other organizations, the Air Surgeon is charged with the maintenance of liaison with domestical and foreign governmental and civilian research organizations such as the ASF, AGF, Navy Department, National Research Council (U. S.), National Research Council (Canada), RAF, RCAF, RAAF, etc. The reports received from these organizations are distributed by the AAF School of Aviation Medicine to:

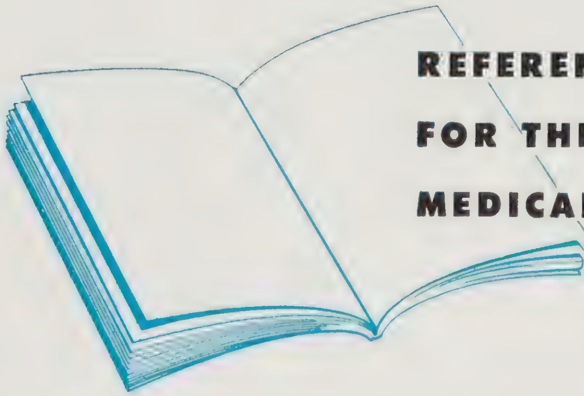
All AAF commands and air forces.
Altitude training units.
Psychological units.
AAF schools and laboratories.
AAF regional and convalescent hospitals.

Research reports are available to AAF medical officers through these organizations.

Reports written within the AAF are distributed to the agencies outside the AAF with which the Air Surgeon maintains liaison.

REFERENCES

AAF Reg. 25-18, Medical research in the AAF, 22 Dec 1944.
AAF Ltr. 20-65, Mission of medical research facilities, 21 Dec 1944.



REFERENCES FOR THE AAF MEDICAL OFFICER

There are numerous military sources other than the usual medical journals listed in the Quarterly Cumulative Index Medicus from which the AAF medical officer may get current medical information. These can best be classified on the basis of their origin.

War department publications:

1. Circular letters.
2. Circulars.
3. Technical Bulletins (TB MED).
4. Training Circulars.
5. Field Manuals.
6. Technical Manuals.
7. Field Bulletins.
8. Training Films.
9. Film Strips.
10. Film Bulletins.
11. Mobilization Training Program.
12. Army Regulations.
13. Mobilization Regulations.
14. Technical Regulations.
15. WD Pamphlets.
16. Bulletin of the U. S. Army Medical Department.
17. Letters, Office of the Surgeon General.

AAF publications:

1. Regulations.
2. Memoranda.
3. AAF Letters.
4. Training Films.
5. Film Strips.
6. Technical Orders.
7. Manuals.
8. Training Standards.
9. Air Surgeon's Bulletin.
10. Letters, Office of the Air Surgeon.
11. Aviation Physiologist's Bulletin.
12. Aviation Psychology Research Bulletins.
13. Aviation Psychology Technical Bulletins.
14. Analysis of the Duties of Aircrew Personnel Bulletins.

Schools and miscellaneous:

The School of Aviation Medicine, the AAF School, the Office of Flying Safety, and the Arctic, Desert, and Tropic Branch of the AAF Center have at various times put out publications of sufficient general interest to receive wide distribution among medical officers. In the future, the number of such publications probably will be reduced, for it is planned that the Flight Surgeon's Reference File will serve as the medium for them.

REFERENCE LIBRARIES FOR THE AAF MEDICAL OFFICER

The permanent library:

The AAF medical officer, particularly the flight surgeon, will have need, as time goes on, to refer for historical and other purposes to older works dealing exclusively with aviation medicine. In order to help him with this task, the following list of texts and manuals has been prepared. It will be noted that specialized texts, monographs, and journals have been omitted. A complete listing of these may be found in Hoff and Fulton's "Bibliography."

Texts:

1. Anderson, H. C.: The medical and surgical aspects of aviation, New York, Oxford Medical Publications, 1919.

2. Air service medical (Parts I and II), War Department, Air Service Division of Military Aeronautics, Washington, U. S. Government Printing Office, 1919.

3. Aviation medicine in the A.E.F., War Department, Director of Air Service, Washington, U. S. Government Printing Office, 1920.

4. Cruchet, R. and Moulinier, R.: Air sickness: its nature and treatment (translated by J. R. Earp), New York, William Wood Co., 1920.

5. Bauer, L. H.: Aviation medicine, ,Baltimore, Williams and Co., 1928; Oxford Press, 1942.

6. U. S. Army Air Corps stratosphere flight of 1935 in the balloon "Explorer II," The National Geographic Society, Stratosphere Series No. 2, Washington, National Geographic Press, 1936.

7. Ocker, W. C., and Crane, C. J.: Blind flight in theory and practice, San Antonio, Naylor Printing Co., 1932.

8. Armstrong, H. G.; Principles and practice of aviation medicine, Baltimore, Williams and Wilkins Co., 1939; 2nd Ed., 1943.

9. Ruff, S., and Strughold, H.; Grundriss der luftfahrtmedizin, Leipzig, J. B. Barth, 1939.

10. Fundamentals of aviation medicine, Pavlov Institute of Aviation Medicine, Leningrad, 1939 (translated by Fl. Lt. I. Steiman, RCAF; Edited and distributed by Associate CAM Research, NRC, Canada).

11. Von Diringshofen, H.: Medical guide for flying personnel (translated by V. E. Henderson), Toronto, University of Toronto Press, 1940.

12. Grow, M. C., and Armstrong, H. C.: Fit to fly; a medical handbook for flyers, New York, D. Appleton-Century Co., 1941.

13. Henderson, V. E.: Air crew in their element, Toronto, University of Toronto Press, 1942.

14. Van Liere, E. J.: Anoxia; its effect on the body, Chicago, University of Chicago Press, 1942.

15. Hoff, E. C., and Fulton, J. F.: A bibliography of aviation medicine, Springfield, Charles C. Thomas, 1942; Supplement, CAM, Division of Medical Sciences, NRC, 1944.

16. Gemmill, C.: Physiology of aviation, Springfield, Charles C. Thomas, 1942.

Manuals and miscellaneous:

1. Flight Surgeon's Handbook, 1st Ed., Randolph Field, School of Aviation Medicine, 1942; 2nd Ed., 1943.

2. Field manual for medical officers, Warner Robins Army Air Depot, Ga., Medical Training Section, Air Service Command, 1942.

3. TM 1-705, Physiological aspects of flying, Washington, U. S. Government Printing Office, 1943.

4. Physiology of flight, human factors in the operation of military aircraft, Wright Field, Aero Medical Research Laboratory, 1942.

5. Outline of course of instruction in high altitude physiology, Wright Field, Aero Medical Research Laboratory, 1941.

6. TM 8-300, Notes on eye, ear, nose and throat in aviation medicine, Washington, U. S. Government Printing Office, 1940.

7. TM 8-305, Notes on cardiology in aviation medicine, Washington, U. S. Government Printing Office, 1940.

8. TM 8-310, Notes on physiology in aviation medicine, Washington, U. S. Government Printing Office, 1940.

9. TM 8-320, Notes on psychology and personality studies in aviation medicine, Washington, U. S. Government Printing Office, 1941.

10. TM 8-325, Outline of neuropsychiatry in aviation medicine, Washington, U. S. Government Printing Office, 1940.

11. T. O. No. 30-105-1, Your body in flight, Wright Field, Aero Medical Laboratory, 30 Sept. 1944.

12. Aviation otolaryngology, Randolph Field, AAF School of Aviation Medicine, 1944

13. Outline of neuropsychiatry in aviation medicine, Randolph Field, AAF School of Aviation Medicine, 1944.

14. AAF Manual 25-2, Physiology of Flight, 1945.

Journals:

1. Journal of Aviation Medicine, The Aero Medical Association, Louis H. Bauer, Editor, Hempstead, N. Y.

2. Journal of the Aeronautical Sciences, Institute of the Aeronautical Sciences, N. Y., N. Y.

3. Air Surgeon's Bulletin, The Air Surgeon, Publications Branch, Washington, D. C.

4. Air Force, official journal of the U. S. Army Air Forces, N. Y,. N. Y.

The field library:

In preparing a field library for a flight surgeon or AAF medical officer one important consideration is the weight of the material, for in large part travel by air to the theatre of operations will be by aircraft already loaded with the accoutrements of war.

The best procedure is for the medical officer to learn as best he can his approximate destination and carry with him in addition to this file material on medical problems he is likely to encounter. The references given in this manual at the end of each subject will usually be procurable on a large base. In addition, a textbook on surgical anatomy, on general surgery, and on therapeutics will be found of inestimable value to the flight surgeon in the small unit.

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REFERENCE FILE

Additional copies of this manual should be requested from:

Commandant, AAF School of Aviation Medicine, Randolph Field, Texas

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BY COMMAND OF GENERAL ARNOLD:

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